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THE CYDNIDAE AND PENTATOMIDAE OF CUBA *

By H. G. BARBER, U. S. Bureau of Entomology and S. C. BRUNER, Cuban Agricultural Experiment Station.

The present paper is based largely on specimens in the collections of the Cuban Agricultural Experiment Station at Santiago de las Vegas and of the junior author, together with specimens in the Dr. Juan Gundlach collection which is housed in the Instituto de Segunda Enseñanza de la Habana. A close examination of the specimens in the latter has not been possible as they are preserved in sealed, glass-topped boxes from which they can not be removed for study. The species in the collection of Gundlach were named in 1883 by Professor Philip R. Uhler according to a note in the preface of his catalogue which was never published. This catalogue includes the names and synonymy of the species where known, the localities where collected, and the numbers assigned to each species both in his collection and in that of his contemporary, the Cuban naturalist Don Felipe Poey. In 1910 Dr. Pedro Valdés Ragués published a list of species in the Gundlach collection under the title "Clasificación Gundlach de Hemípteros Cubanos, Conforme a los ejemplares que Existen en el Museo del Instituto de 2a. Enseñanza de la Habana" (Anales de la Academia de Ciencias Médicas, Físicas y Naturales de la Habana, XLVI, 425–446). As noted in a copy of this list referred to later, many of the names are misspelled, so much so that some of them are scarcely recognizable. In addition to the collections of Cuban Pentatomidae mentioned above we have been able to add other species and much additional data from material in the U. S. National Museum, the Museum of Comparative Zoology, and the American Museum of Natural History. We have also frequently referred to the important article by Mr. F. E. Guérin-Méneville published in 1857 in Ramón de la Sagra Histoire Physique, Politique et Naturelle

* *Editor's Note:* The paper here published includes a number of species widely distributed in the West Indies and known also to occur in Puerto Rico. The economic importance of these stink-bugs makes the accurate diagnoses and the keys for determination of the species included of great value to all West Indian workers. This study furnishes an important comparison to a comprehensive paper now in preparation by Mr. Barber on the Heteroptera for the Scientific Survey of Puerto Rico and the Virgin Islands which includes the two families here treated.

de l'Isle de Cuba, Animaux Articulés a Pieds Articulés 359–377, in which a number of new species are described. Appended to our treatise we have arranged in parallel columns the two lists of Cuban Pentatomidae as given by Guérin and Ragués, and in the third column our determination. The illustrations were made by the senior author.

The abbreviations adopted are as follows: Est. Exp. Agron. for Estación Experimental Agronómica, Cuba; M. C. Z. for Museum of Comparative Zoology; U. S. N. M. for U. S. National Museum; A. M. N. H. for American Museum of Natural History.

The full names of the various collectors to whom credit is due are as follows: J. Acuña, C. H. Ballou, B. T. Barreto, P. Betancourt, L. Bouclé, S. C. Bruner, P. Cardín, C. Enamorado, W. T. Horne, J. H. Houser, J. C. Hutson, Frederick Knab, G. Link, W. M. Mann, Harold Morrison, J. G. Myers, A. Otero, S. Plá, H. K. Plank, Hermano Roberts, George Salt, L. C. Scaramuzza, E. A. Schwarz, F. Silvestri, G. F. Stahl, and G. N. Wolcott.

Types and paratypes of the new species are deposited in the U. S. National Museum and paratypes in the collection of the Cuban Agricultural Experiment Station at Santiago de las Vegas.

KEY TO CUBAN FAMILIES AND SUBFAMILIES OF PENTATOMOIDEA *

1. Tibiae distinctly spinose or spinulose, rarely setose. Only five visible dorsal segments in connexivum of abdomen (excluding genital segments). First ventral segment of abdomen, at least outwardly, entirely or almost entirely covered by the expanded margin of the metapleurum.....Fam. *Cydnidae* 2

   Tibiae not distinctly spinose or spinulose, sometimes provided with setulae. Connexivum of abdomen provided with six dorsal segments (excluding genital segments). First ventral segment of the abdomen not entirely covered by the metapleurum.....Fam. *Pentatomidae* 3

2. Scutellum much expanded, U-shaped, nearly covering abdomen. Corium for the most part membranous and concealed; frena very short; exposed chitinous part narrow. Tibiae sometimes spinulose.....Subfam. *Thyreocorinae*

   Scutellum of moderate size, somewhat triangular, not reaching to apex of abdomen. Clavus and corium not concealed beneath scutellum; frena long. Tibiae commonly more strongly spinose (except *Scaptocoris*).....Subfam. *Cydninae*

3. Scutellum expanded, U-shaped, nearly or quite reaching apex of abdomen. Chitinized part of corium exposed at base only or along narrow costal margin 4

   Scutellum of moderate size, commonly triangular, rarely U-shaped or reaching apex of abdomen; in the latter case the entire corium and clavus free. Subcostal and median veins set close together and parallel in Cuban species 6

* This key is intended only for differentiation of Cuban forms.

4. Fore wings very long, when expanded almost twice as long as abdomen; chitinized costal margin constricted and thinned at the middle point. Odoriferous orifice of the metapleurum minute, devoid of a canal and surrounding, dull, evaporating area. Antennae with only four segments. Tarsi with two segments----------Subfam. *Megaridinae.*

Fore wings not much longer than abdomen, when expanded; chitinized costal margin complete, not constricted in the middle. Odoriferous orifice distinct; canal present or absent. Tarsi three segmented---------- 5

5. Median and subcostal veins of hind wings more or less distant and diverging, enclosing a wide median area; hamus often present. Scutellum nearly covering abdomen in Cuban species----------Subfam. *Scutellerinae.*

Median and subcostal veins of hind wings set close together and nearly parallel; hamus absent. Scutellum not entirely covering abdomen in Cuban species; corium in part membranous----Subfam. *Graphosomatinae.*

6. Venter of abdomen provided with six visible spiracles on each side, first not covered by the expanded margin of the metapleurum. Rostrum short, commonly not extended to middle coxae. Mesosternum provided with a very strongly elevated carina prolonged anteriorly from a flat metasternal plate----------Subfam. *Tessaratominae.*

Venter of abdomen with five visible spiracles on each side, the first entirely or almost entirely covered by the expanded margin of the metapleurum-- 7

7. Bucculae nearly parallel or slightly diverging, not distinctly united posteriorly. Basal segment of rostrum commonly not free but confined in the rostral groove between the bucculae; rostrum commonly slender---------- ----------Subfam. *Pentatominae.*

Bucculae converging and united posteriorly. Basal segment of rostrum enlarged and free from rostral groove, except at base; rostrum commonly thickened----------Subfam. *Asopinae.*

Family Cydnidae

Subfamily Thyreocorinae

KEY TO CUBAN GENERA OF THE SUBFAMILY THYREOCORINAE

1. Pronotum and scutellum (seen from the side) not forming together a uniform continuous curve. Costal margin of corium not longitudinally impressed, calloused. Head subtriangular, rather convex. Eyes more or less prominent beyond margins of head----------*Eucoria* M. and R.

Pronotum and scutellum (seen from side) forming together a uniform continuous curve. Costal margin of corium longitudinally impressed. Eyes not prominent. Coriaceous part of fore wings not acute at apex but broadly truncate or obtusely rounded. Head more bluntly rounded anteriorly and rather flattened----------*Euryscytus* Horv.

Eucoria minuta (Uhler)

1863. Uhler, Proc. Ent. Soc. Philad. II: 155.

Santiago de las Vegas; El Faaile, Pen de Guanahacabibes (Bruner); Camagüey (Acuña); Baracoa, Ote. (Bruner and Bouclé);

Sto. Tomás, Pen de Zapata (Bruner and Acuña); Nueva Gerona in Isle of Pines (Bouclé)—Est. Exp. Agron. "Cuba"—U. S. N. M.

Originally described from Cuba and a fairly common species in other West Indian Islands. It is a small species, only about 2-2.5 mm. long, quite dull and closely punctate, with a bright orange costal margin.

Euryscytus incerta (Uhler)

1863. Uhler, Proc. Ent. Soc. Philad. II: 156.

Santiago de las Vegas (Cardín, Otero, and Bruner)—Est. Exp. Agron. "Cuba"—U. S. N. M.

Cuba is likewise the type locality of this species. It is a little larger than the preceding species, quite shiny and rather sparsely punctate. The exposed costal margin is ochraceous-red interrupted by a fuscous spot beyond the middle point.

Euryscytus guttiger (Stal)

1862. Stal, Stett, Ent. Zeit. XXIII: 94.

Santiago de las Vegas (Bruner); Camagüey (Acuña)—Est. Exp. Agron. San Carlos Estate, Guantánamo—A. M. N. H. Mina Carlota, Trinidad Mts. (Myers)—M. C. Z.

Described from Mexico and found occasionally in Cuba. It is nearly 4 mm. long. The head is very broad and rounded in front, about twice as wide as long, and very finely punctured; the scutellum is short and relatively narrow, leaving exposed most of the corium, which is broad and truncate at apex. A large pale yellow patch occupies the base of the corium. This is evidently the species referred to by Guérin in La Sagra, Hist. de Cuba, Ins., 364 as *Scutellera (Corimeloena) basalis* Germár.

Subfamily Cydninae

KEY TO CUBAN GENERA OF SUBFAMILY CYDNINAE

1. Anterior tibiae sickle shape and flattened; tarsus inserted before apex of tibia. Rostrum short, not surpassing anterior coxae; second segment swollen. Margins of head devoid of spines and setae, more or less crenulate. Apex of scutellum bluntly rounded. Posterior femora and tibiae short and incrassate, with the latter truncated at apices *Scaptocoris* Perty
   Anterior tibiae normal, fossorial; tarsus inserted at apex of tibia. Rostrum much surpassing anterior coxae. Posterior tibia elongate, somewhat cylindrical 2
2. Odoriferous orifice terminating in a long, distinctly elevated canal. Margins of head armed with comb-like teeth or spines. Two clavi of the fore wings meeting behind scutellum to form a commissure. Scutellum acute at apex ..... *Amnestus* Dallas

Odoriferous orifice not terminating in a long distinct canal, set beneath an overhanging ledge. Two clavi of fore wings not meeting behind scutellum, devoid of a commissure. Scutellum not acute at apex. Anterior submargin of pronotum not transversely impressed 3

3. Submargins of head deeply grooved and beset with slender, acute spines and long setae ..... *Aethus* Dallas.

Submargins of head neither deeply grooved nor armed with spines 4

4. Outer end of the short odoriferous canal flaring or expanded in the form of a concave lobe ..... *Geotomus* M. and B.

Odoriferous orifice set in a preapical notch of the overhanging ledge, not flaring or expanded exteriorly ..... *Geocnethus* Horv.

Scaptocoris terginus Schioedte

1849. Schioedte, Kroy. Nat. Tidskr. II: 460.

1881. Signoret, Ann. Soc. Ent. Fr., p. 42; Pl. I, Fig. 3.

A South American species recorded by Signoret from Cuba. There is a specimen from the island of Trinidad in the National Museum collection but none from Cuba.

Aethus communis Uhler

1877. Uhler, Bull. U. S. Geol. Geogr. Surv. III: 379.

1882. Signoret, Ann. Soc. Ent. Fr. (6) II: 35, Pl. 2, Fig. 76.

Taco Taco (Bruner, Acuña, and Ballou); Santiago de las Vegas (Barreto); Havana (Bruner); Península de Guanahacabibes, Pinar del Rio (Bruner)—Est. Exp. Agron. Cayamas (Schwarz), Baraguá (Scaramuzza)—U. S. N. M.

Described by Uhler from our southern states and Cuba. It is black, about 6–7 mm. long, with the bluntly rounded head provided on each side with 10–11 short submarginal spines and several long setae. The pronotum is almost impunctate and provided with a submarginal row of 16–18 long setae; costal margin of the hemielytra furnished with about six long setae.

Aethus indentatus (Uhler)

1887. Uhler, Bull. U. S. Geol. Geogr. Surv. III: 380.

1882. Signoret, Ann. Soc. Ent. Fr. (6) II: 38, pl. 2, Fig. 80.

Santiago de las Vegas (Barreto, Acuña, and Bruner)—Est. Exp. Agron. Soledad and Mina Carlota (Myers)—M. C. Z. Cabanas, Pinar del Rio—A. M. N. H. Cayamas (Schwarz)—U. S. N. M.

Described from Cuba and southern Florida. Much smaller than the preceding species. It has a few spines on each lateral lobe of the head (5–6), five setae on the lateral margin of the pronotum, and but a single setigerous puncture on the coastal margin. The males have the anterior disk on the pronotum quite plainly depressed.

Geocnethus Horvath

1919. Horvath, Ann. Mus. Nat. Hung. XVII: 245.

Closely related to *Geotomus* in which genus Signoret placed several species which Horvath remarks belong to Geocnethus. The submargin of the head is neither deeply impressed nor armed with spines; eyes posteriorly with a single fine horizontal seta; entire lateral margin of pronotum impressed; odoriferous orifice lying preapically in a semicircular notch at the posterior margin of the broad, elevated ridge which terminates abruptly about midway on the pleurum; first and second segments of the posterior tarsus together much longer than third segment. Hussey (Jn. N. Y. Ent. Soc. XXXIII: 63, 1925) has further diagnosed this genus in which he includes *Geocnethus cavicollis* Blatch, from Florida.

Geocnethus cubensis, new species

Black, shining; subcostal area of corium, femora, and tibiae castaneous; antennae, rostrum, and tarsi testaceous.

Head one-third wider than long, evenly semicircularly rounded in front; tylus as long as juga; edge smooth, calloused, not impressed or reflected; surface impunctate; base of tylus and juga faintly wrinkled, each of the latter provided with three long erect setae situated as follows: one near the center just before the middle, one near lateral margin just before the eye, and the third midway near inner margin of eye; also a submarginal pair below head projecting anteriorly; vertex somewhat elevated; ocelli five or six times as remote from each other as each is distant from eye; ocular seta short. Bucculae evenly elevated, reaching base of head, distinctly punctate. Rostrum with apex extending to middle of intermediate coxae; second and third segments nearly equal; fourth one-third shorter. Antennae with more slender second segment a little longer than third; last three segments finely pilose, somewhat more incrassate; fourth and fifth nearly equal, each one-third longer than third. Pronotum with the lateral margins gently rounding, the edge narrowly impressed throughout; submargin provided with five setigerous punctures, three anteriorly and two just behind the middle; dorsal surface smooth; anterior submargin in female distinctly depressed; nearly impunctate, a setose puncture near each anterior angle; a cluster of three or four near anterior margin directly back of ocelli; a few punctures across the disk behind the middle where it is not at all impressed. Scutellum one-fifth longer than wide; apical sixth narrow, rounded at apex; narrowly depressed and with a linear row of punctures along margins; smooth across basal portion preceded by a row of punctures at extreme depressed basal margin; disk very sparsely coarsely punctate. Hemielytra with clavus provided with a single row of coarse punctures; corium with a single row of punctures paralleling the claval suture, with another incomplete row paralleling these becoming obsolete posteriorly; disk of mesocorium otherwise impunctate; subcostal nerve linearly punctate on each side; subcostal region (exocorium) impunctate, narrow at basal fourth, thence gradually widening posteriorly where it is subparallel to costal margin; edge of costa with two widely separated setigerous punctures. Membrane sordid white, clouded with fuliginous towards base. Pleura

almost impunctate; mesosternum carinate; metapleural odoriferous orifice as discussed in generic diagnosis. Legs with anterior coxae setose at apices; anterior femora somewhat incrassate, flattened below, with five or six minute setose tubercles along anterior lower edge and from four to five long setae along the posterior edge; anterior tibiae outwardly armed with five to six spines, increasing in length apically, inwardly armed with a single long preapical spine and several more at apex; intermediate and posterior femora somewhat compressed, sparsely setose, and armed below with a row of fine short spines, tibiae cylindrical, uniformly long-spinose; basal segment of posterior tarsus nearly twice as long as the apical two united. Venter smooth, nearly impunctate; second abdominal segment at base distinctly and apical margins of segments 2–4 faintly carinulate; segments 2–6 laterally provided with two long setose hairs; lateral margin of sixth segment just behind middle armed with a bristle or slender spine. Male hypopygium (seen from below) obtusely rounded, entire. Length 6 mm.

Type, male: Cayamas, Apr. 3 (E. A. Schwarz)—U. S. N. M. *Paratype, female:* Sierra Rangel, Aug. 28, 1929 (J. Acuña and S. C. Bruner)—Est. Exp. Agron. Cat. No. 44043, U. S. N. M.

This has been wrongly determined as *Pangaeus piceatus* Stal and probably is the species so labeled in the Gundlach collection. What we have taken as the paratype differs in several respects from the type as follows: the pronotum just back of the anterior margin has distinct transverse depression, about as long as the space between the ocelli, and a distinct setigerous pit just in front and near the outer limits of this depression; the disk behind the middle has several faint transverse furrows; the sides of the venter are provided with a cluster of small punctures before and behind each spiracle.

Geocnethus reversus new species

Plate XXV, Fig. 1

Black, highly polished. Antennae and rostrum embrowned; tarsi testaceous, remainder of legs castaneous.

Head bluntly, semicircularly rounded; three-sevenths wider than long; lateral submargins lightly impressed and very slightly reflexed; tylus contracted anteriorly; surface of lateral lobes irregularly, faintly wrinkled and very sparsely punctate; each of these provided with six long erect setae placed as follows: four along the submargin, one anteriorly in the center of the lobe and another near the inner margin of the eye, all set in enlarged pits; ocelli five times as far apart as each is removed from eyes; ventral submargin with two long, porrect setae. Antennae 1.44 mm. long, apex of basal segment just visible beyond margin of head; relative lengths of the segments as follows: I, .24; II, .2; III, .24; IV, .36; V, .4 mm. Rostrum reaching to middle coxae, second segment a little longer than third, fourth one-third shorter than third. Pronotum about three-sevenths wider than long; lateral margins, seen from above, gently rounding anteriorly; submargin beset with five long setae; anterior disk impunctate, laterally coarsely and sparsely punctate; anterior submargin furnished with a tranverse series of 14–19 coarse punctures, terminating back of each eye

in a prominent setigerous pit, another setigerous pit at each anterior angle; a transverse row of coarse punctures a little behind middle, with a few scattered ones behind this on the central disk. Scutellum one-seventh longer than wide, smooth anteriorly, sparsely and coarsely punctate posteriorly; a line of closely set punctures along the margins. Corium with two rows of punctures paralleling the claval suture; mesocorium anteriorly with a short, longitudinal row, elsewhere with a few scattered punctures; subcostal region and outer apical angles rather closely punctate; costal margin with two widely separated setigerous punctures. Membrane lightly infumed. Ventral segments smooth, with a few punctures about the spiracles; anterior margin of segments furnished with a line of punctures (carinulate). Anterior femur and tibia as shown in the drawing. Length 5 mm.; humeral diameter 2.5 mm.

Type male: Mayagüez, Puerto Rico, IX, 10, 1930 (Coll. by L. L. Martorell). *Paratype, male:* Mayagüez, Puerto Rico, IX, 15, 1930 (Coll. by A. Suro); *Paratype, female:* 1 Isabella, Puerto Rico, IV, 14, 1930 (Coll. by M. D. Leonard at light); 1 Río Piedras, Puerto Rico, XII, 21, 1911; 2 Cayamas, Cuba (Coll. by E. A. Schwarz). All in the collection of the U. S. National Museum. Cat. No. 44044, U. S. N. M.

This is about the size and general appearance of *Aethus indentatus* Uhler, with which it has been confused. The absence of marginal spines of the head and the character of the punctuation of the pronotum will serve to differentiate it. It is somewhat smaller than *G. cubensis* n. sp. with relatively much shorter antennae, the anterior submargin of pronotum and corium more profusely punctate.

Geotomus spinolai Signoret

1863. Signoret, Ann. Soc. Ent. Fr., p. 545; Pl. 12, Fig. 2.

One specimen labeled Cuba in the U. S. National Museum is in poor condition.

Signoret remarks that this is distinguishable from all of the related forms by the fact that neither the lateral nor the median lobes of the head have the usual setae, and they have a line of strong punctures in the marginal space.

Amnestus pusillus Uhler

1875. Uhler, Bull. Geol. Geogr. Surv. I:278; III:371 (1878).

1883. Signoret, Ann. Soc. Ent. Fr., 372; Pl. 10, Fig. 197.

Recorded by both Uhler and Signoret from Cuba and Texas. Now known to be widely distributed in the United States. The authors have not seen this species from Cuba, and all of the specimens from that island remaining in the Uhler collection at the U. S. National Museum belong to the next species. Specimens of *pusillus* from

Texas are ochraceous yellow in color with the fore femora of the male usually having a small simple spine a short distance from the base; the hind femora armed with a very long spine nearly half as long as the tibia; hind tibia curved and finely serrate toothed along the inner edge; the anterior margin of the pronotum more strongly concave than in *pusio* for the reception of the head.

Amnestus pusio Stal

1858. Stal, Bidrag till Rio Jan. Hem. I: 14.

1883. Signoret, Ann. Soc. Ent. Fr. 373; Pl. 15, Fig. 199.

Vibora, Havana (Bruner); Sto. Tomás, P. de Zapata (Bruner and Acuña); Manacas, Sta. Clara (Bruner)—Est. Exp. Agron. Cayamas (Schwarz); Santiago (Morrison)—U. S. N. M. Recorded from Cuba by Signoret.

Of the same general color as the preceding but somewhat smaller. The fore and hind femora of the male each armed with a short spine, the former sometimes bifid; the hind tibia straight and not serrate toothed along inner edge; the anterior margin of the pronotum not so deeply concave for the reception of the head. According to Blatchley this species occurs in Florida and several specimens from Bedford City, Va., are in the collection of the National Museum.

Amnestus subferrugineus (Westwood)

1837. Westwood, in Hope Cat. I: 19.

1883. Signoret, Ann. Soc. Ent. Fr. 373; Pl. 10, Fig. 198.

Jarahoeca Ote. (Bruner)—Est. Exp. Agron. Specimens in the U. S. National Museum collection are from the West Indian islands St. Vincent, Grenada, San Domingo, Martinique, and Dominica.

This species is larger than the other two mentioned, averaging 2.5–3 mm. long and of a ferruginous or dark castaneous color on the head, pronotum, scutellum, and beneath; the hemielytra are paler with castaneous maculations. The disk of the anterior lobe of the pronotum is smooth, exhibiting a row of coarse punctures along the anterior margin. The anterior femora of the male have a prominent oblique bifid tooth and the posterior femora are armed with a rather long, sometimes curved, spine before the apex.

KEY TO CUBAN SPECIES OF AMNESTUS

1. Color ferruginous to dark castaneous; pale hemielytra marked with castaneous; anterior femora of male with a prominent bifid spine; anterior disk of pronotum smooth ..... *subferrugineus* (Westw.)
   Color yellow ferruginous; anterior femora of male unarmed or with a small spine; anterior disk of pronotum punctate 2

2. Posterior femora of the male armed with a very long spine and the posterior tibia curved and serrate along inner edge; anterior margin of pronotum deeply concave----------*pusillus* Uhler
Posterior femora of male with a short, oblique spine and posterior tibia straight, not serrate, inwardly; anterior margin of pronotum not deeply concave. Smaller species----------*pusio* Stal

Family Pentatomidae

Subfamily Megaridinae

Megaris majusculus McAtee and Malloch

1928. McAtee and Malloch, Proc. U. S. Nat. Mus. LXXII, Art. 25, p. 6.

Novaliches, Guantánamo (C. T. Ramsden). Known only from the holotype which is in the collection of the American Museum of Natural History.

Subfamily Scutellerinae

KEY TO CUBAN GENERA OF SUBFAMILY SCUTELLERINAE

1. Venter devoid of a stridulating area on each side of the disk; ventral incisures gradually curved on central disk, abruptly arcuated before the lateral margins. Antenna with four segments; second segment very long in *A. illustris*, much longer than first. Odoriferous canal long and distinct. Scutellum entirely covering abdomen----------*Augocoris* Burm.
Venter provided with a stridulating area on each side of the disk, at least occupying the fourth and fifth segments. Antenna with five segments--- 2

2. Pronotum with a distinct transverse impression near the middle. Head about as long as the pronotum, strongly convex----------*Camirus* Stal.
Pronotum devoid of a transverse impression. Head shorter than pronotum-- 3

3. Odoriferous orifice placed as close to the lateral margin of the metapleurum as to the posterior coxae, or more remote from the coxae than from the lateral margin of the metapleurum, very rarely prolonged in a canal----- 4
Odoriferous orifice more remote from the lateral margins of the metapleurum than from the posterior coxae, most often (except in *Diolcus*) prolonged in a canal---------- 5

4. Scutellum not as wide as abdomen. Connexivum free. Head obliquely truncate anteriorly on each side. Pronotum and scutellum not spotted with red----------*Tetyra* Fab.
Scutellum as wide or very nearly as wide as abdomen. Connexivum not entirely free. Head entirely rounded anteriorly. Pronotum and scutellum spotted with red----------*Pachycoris* Burm.

5. Odoriferous orifice not terminating in a canal. Anterior face of tibia with two longitudinal grooves separated by a median longitudinal ridge------ ----------*Diolcus* Mayr.
Odoriferous orifice terminating in a distinct canal. Anterior face of tibia provided with a single wide, longitudinal groove---------- 6

6. Canal from odoriferous orifice gradually expanded outwardly and turned abruptly forward at a right angle before lateral margin of metapleurum. Sixth ventral segment of abdomen not twice as long through middle as along lateral margin ..... *Sphyrocoris* Mayr.

Canal from odoriferous orifice straight, nearly transverse, the margins parallel. Sixth ventral segment of abdomen about twice as long through middle as along lateral margin ..... *Symphylus* Dallas.

Tetyra antillarum Kirkaldy

1794. *arcuatus* (Fabricius), Ent. Syst. IV: 83.

1909. *antillarum* Kirkaldy, Cat. Hem.-Cim. 284 (new name).

Soledad (Myers)—M. C. Z. San Blas, Santa Clara Prov. (G. H. Rowe)—Est. Exp. Agron.

A species fully as large as *T. bipunctata* H. S., from which it may be distinguished structurally by the following differences: a little more depressed; head relatively shorter with lateral margins before eyes more strongly sinuate; lateral margins of pronotum more evidently sinuate. The antennae are usually distinctly banded with yellow and black.

Pachycoris fabricii (Linnaeus)

1771. Linnaeus, Mant. Plant. II: 534.

1863. *Pachycoris wilsoni* Uhler, Proc. Ent. Soc. Philad. II: 159.

Soledad (Myers)—M. C. Z. "Cuba" (Uhler Coll.—U. S. N. M.)

Uhler's type of *wilsoni*, a female, is in the collection of the National Museum, also a male labeled "Cuba"—"Gundlach" in Uhler's well known hand. The male specimen lacks the two yellow patches on the head and the yellow maculations below are reduced to only the outer apical angle of the metapleurum and a small spot on either side of the fifth and sixth abdominal segments. We conclude that *wilsoni* is only a color form of the West Indian *fabricii*. It was reported from Cuba by Guérin as *Scutellera (Pachycoris) nitens* Dallas.

Diolcus boscii (Fabricius)

1798. Fabricius, Ent. Syst. Suppl. 529.

1868. *Symphylus politus* (Walker), Cat. Hem. III: 518.

Taco Taco (Bruner, Acuña, and Ballou); Santiago de las Vegas (Acuña and Bruner); Camagüey (Acuña); Viñales (Bruner)—Est. Exp. Agron. Soledad (Myers and Salt)—M. C. Z.

Recorded from Cuba by Guérin. It may be readily distinguished from the other species of the genus by the longer rostrum which reaches well behind the posterior coxae; abdomen ventrally deeply sulcate in front; golden green punctures dorsally and ventrally; also with more or less distinct irregular pale dots on scutellum.

Diolcus variegatus (Herrich-Schaeffer)

1836. Herrich-Schaeffer, Wanz. Ins. III: 106, Fig. 332.

Manzanillo (Bruner and Ballou); Viñales (Bruner); Santiago de las Vegas (Barreto); Camagüey (Acuña); Palmira (Ballou); Itabo (Cardín)—Est. Exp. Agron. Soledad (Myers)—M. C. Z. Cayamas (Schwarz); San Blas de Río (Mann); Central Jaronú (Scaramuzza); Baraguá (Scaramuzza)—U. S. N. M.

Diolcus irroratus (Fabricius)

1775. Fabricius, Syst. Ent. 699.

1923. *D. boscii* Barber (nec Fab.), Amer. Mus. Nov. No. 75: 12.

Camagüey (Acuña); Cojimar (Bruner); Hoyo Colorado (Enamorado)—Est. Exp. Agron. Baraguá (Scaramuzza)—U. S. N. M. Guérin reported this from Cuba; it is much less numerous there than either of the foregoing species of *Diolcus*.

KEY TO SPECIES OF DIOLCUS FROM CUBA AND UNITED STATES

1. Head longer, very nearly as long as wide, not punctate to extreme edge. Lateral margin of the pronotum slightly concavely arcuate before the middle. Venter shallowly grooved anteriorly. Antennae basally pale, apically banded with black. Not punctate with green_____*variegatus* (H. S.)
   Head shorter, nearly one-third or more wider than long, as seen dorsally punctate to extreme edge. Lateral margins of pronotum either straight or lightly convexly arcuate. Antennae pale or very lightly tinted with brown _____ 2
2. Lateral margins of pronotum straight, humeri obtusely angled. Head, pronotum, scutellum, and corium punctate with green. Venter smooth, with a few scattered brown and green punctures; a deep groove anteriorly running to middle of the fourth segment_____*boscii* (Fab.).
   Lateral margins of the pronotum lightly convexly arcuate; humeral angles more rounded. Venter with the first three segments shallowly grooved___ 3
3. Head relatively shorter and broader, three-fifths wider than long, forming with the two lateral lobes a bluntly rounded apex. Pronotum punctate to edge; conspicuous greenish punctures on head and pronotum. Scutellum laterally furnished with a round black spot. Venter profusely punctate on both sides of middle. (Florida, Texas, etc.)____*chrysorrhoeus* (Fab.).
   Head relatively longer, somewhat over one-fourth wider than long, forming with the two lateral lobes a more acute angle. Not punctate with green. Pronotum not punctate along pale, lightly reflexed lateral margins. Venter smooth, with large scattered brown punctures_____*irroratus* (Fab.).

Sphyrocoris obliquus (Germar)

1839. Germar, Zeits. Entomol. I: 94.

Manzanillo (Bruner and Ballou); Santiago de las Vegas (Bruner, Barreto, and Acuña); Isla de Pinos (Ballou); Sierra Rangel

(Acuña and Bruner); Camagüey (Acuña); Puerto Tarafa (Bruner); Baraguá (Stahl and Bruner)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Jababo (Scaramuzza); Central Jaronú (Stahl); "Cuba" (Uhler)—U. S. N. M.

This is a common species throughout the West Indies, southern Florida, Mexico, Central America, and Colombia. In this genus the sulcus from the odoriferous orifice is apically abruptly bent forward at a right angle and expanded into a punctate area. Guérin first reported this species from Cuba.

Symphylus caribbeanus Kirkaldy

1857. *Scutellera obliqua* (Guérin), La Sagra, Hist. Cuba. Ins. 362 (not Germar).

1909. *Symphylus caribbeanus* Kirkaldy (new name), Cat. Cim. 280.

1914. *Symphylus deplanatus* Barber, Bull. Am. Mus. Nat. Hist. XXXIII: 526 (not Herrich-Schaeffer).

1926. *Symphylus deplanatus* Blatchley, Heterop. E. No. Amer. 43 (not Herrich-Schaeffer).

Nagua, Oriente (Bruner and Ballou); San Nicolás, Oriente (Bruner); Sierra Rangel, Pinar del Rio (Hermano Roberto)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. "Cuba" as *Mesotrypa sinuosa* Uhler—U. S. N. M.

This variably marked species also occurs in Florida from whence it was differentiated by Hart and Malloch as *Symphylus* sp. (Bull. Nat. Hist. Surv. Ill. 171, 1919) to distinguish it from *Stethaulax marmoratus* Say with which it had been confused. The specimens in the National Museum collection from Ft. Valley, Ga., referred to *Symphylus deplanatus* by Professor Blatchley, are all *Stethaulax marmoratus*. *Symphylus caribbeanus* differs from the foregoing species by having the head more acutely produced anteriorly. It may be well to remark in this connection that after a careful comparison of a long series of *Stethaulax* from the United States with several Neotropical species of *Symphylus* we have come to the conclusion that the former is not deserving of generic rank and that the two genera should be combined. The bisulcate tibia, the only character relied upon for differentiating *Stethaulax*, is not at all evident. *Symphylus deplanatus* H. S. differs from *caribbeanus* in its greater size and more plainly impressed, recurved margins of the pronotum.

Camirus porosus (Germar)

1839. Germar, Zeitschr. Entom. I: 108.

Camagüey (Acuña)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Cayamas (Schwarz)—U. S. N. M.

The only species of the genus found in Cuba. It is dull black, densely punctate above and below, with the exception of the stridulating areas on the venter. The odoriferous orifice or osteole is not continued in a groove, and the pronotum has a distinct transverse impression near the middle. About 4 mm. long.

Augocoris illustris (Fabricius)

1781. *Cimex sexpunctatus* Fabricius, Spec. Ins. II: 339 (name preoc.).

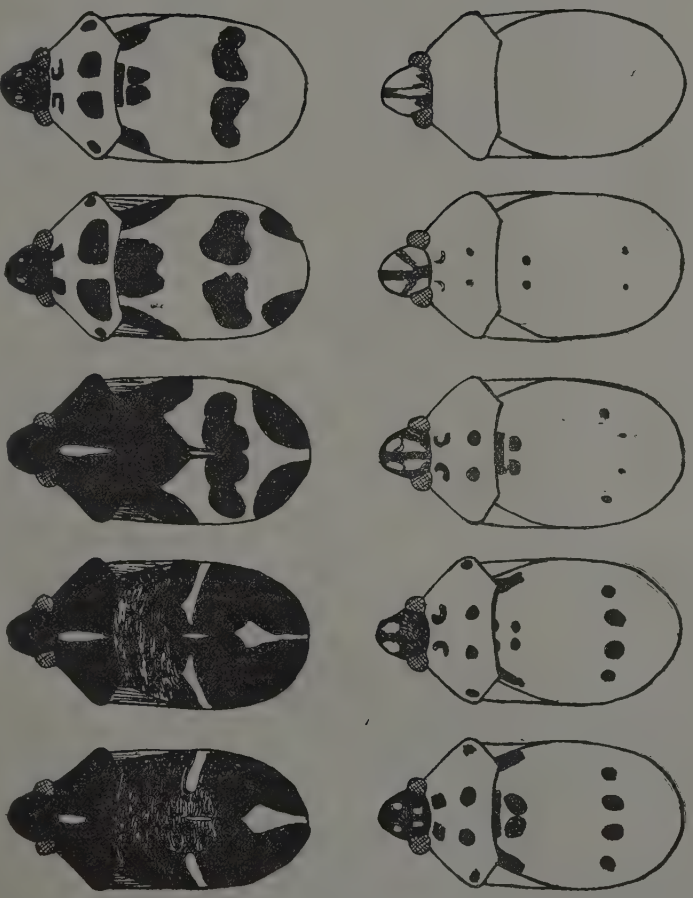
1781. *Cimex illustris* Fabricius, Spec. Ins. II: 340.

1863. *Augocoris poeyi* Uhler, Proc. Ent. Soc. Philad. II: 158.

Camagüey (Acuña); Santiago de las Vegas (Barreto, M. Plasencia); Taco-Taco (Acuña)—Est. Exp. Agron. Jobabo (Stahl); "Cuba" (Uhler coll.)—U. S. N. M.

A large species 13–17 mm. long, which shows a most remarkable variation in both color and form. At one extreme the insect is black above, slightly purplish, marked with orange red as follows: a longitudinal median vitta on pronotum; three maculae on scutellum, two roughly triangular ones on either side before center, and a larger sagittate macula behind, the point touching apical margin. Below, this form is entirely black except the abdomen which is orange red marked with black as follows: the genital segment, the central portion of the sixth segment, and a large subquadrate spot on either side of the remaining segments; also a similar series of spots above almost covering the connexivum. The tibiae and antennae are washed with dark metallic purplish or greenish blue. *A. poeyi* Uhler is near this form but the red markings are larger. The anterior and posterior edges of the postpectus and the exterior edge of the scutellum are not white, however, in our specimens, although rather pale in some of them. At the other extreme the species is largely testaceous to ivory white, sometimes washed with brownish above, with no black except for fusco-piceous markings on head and a rounded spot on either side of the second ventral segment just below the spiracle. This spot and the metallic greenish or purplish blue tibiae and antennae are constant for all varieties but less noticeable on the very dark forms. The femora of the paler forms are rich brownish yellow.

Between these two extremes there are numerous variations com-



Series of Augocoris illustris showing variation.

bining orange or orange red, clay yellow, and black, but following the same general pattern.

More remarkable still is the variation in morphology shown by this species. The dark form is very coarsely rugose above, transversely so on pronotum and anterior portion of scutellum, the latter being strongly and irregularly sculptured behind. This form is probably the same as *A. rugulosus* H. S. The other extreme, the pale variety, has both the pronotum and scutellum perfectly smooth. These two extremes blend one into the other through intermediate forms. This is well demonstrated by a series of 20 specimens reared by Mr. J. Acuña at Camagüey, Cuba, from a single group of freshly hatched nymphs found on a Sapotaceous tree, *Chrysophyllum oliviforme* Lin., the only plant on which this insect has so far been observed in Cuba.

In the National Museum collection there is a specimen from Puerto Rico which agrees with the dark variety of this species from Cuba. No specimen of *A. poeyi* identified by Uhler is in the National Museum collection.

Augocoris illustris has a wide distribution from Mexico through Central and South America as far south as the Argentine Republic. Guérin reported it from Cuba as *Scutellera (Augocoris) cretacea* Voet. and *pallida* Pal. Beauv., both being color varieties of this species.

Subfamily Graphosomatinae

Amaurochrous dubius (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. p. 33, Pl. VI, Fig. 6 (Podops).

Described from Cuba. In the National Museum collection there are two specimens from Florida, one from Georgia, and one from Cuba. It is considerably larger than *cinctipes* Say and differs from that species in the much more produced processes of the anterior angles of the pronotum which project well beyond the line of the eyes.

Subfamily Pentatominae

KEY TO CUBAN GENERA OF SUBFAMILY PENTATOMINAE

1. Basal segment of rostrum not inserted near front of bucculae, set behind middle of head, and apex extended far behind base of head. Rostrum very long, nearly reaching to apex of abdomen. Scutellum extended nearly to apex of abdomen----------*Coriplatus* White.
   Basal segment of rostrum inserted near front of bucculae, apex never extended far beyond base of head. Scutellum mediocre---------- 2

2. Lateral lobes (jugae) of head preapically toothed or obtusely angled. Lateral margins of pronotum armed with stout teeth. Head nearly or quite as long as pronotum. Bucculae extended to base of head------ ------*Brochymena* A. and S.

Lateral lobes of head not furnished with a preapical tooth or obtusely angled. Lateral margins of pronotum either serrate or smooth, rarely armed with teeth *(Neopharnus)*. Bucculae variable------ 3

3. Lateral lobes (jugae) of head acute at apices, surpassing tylus but not contiguous before it. Humeral angles of pronotum acute or acutely spinose------ 4

Lateral lobes of head (jugae) most commonly obtuse anteriorly or if acute then the tylus much longer than jugae *(Proxys)*------ 5

4. Second ventral segment of abdomen produced in a distinct anteriorly directed spine. Mesosternum with a strongly elevated longitudinal median carina ------*Arvelius* Spin.

Second ventral segment of abdomen not produced in a distinct spine. Mesosternum with a low median carina. Apex of femora armed above with a minute spine------*Loxa* A. and S.

5. Metasternum provided with a large, smooth, flattened plate, bifid or notched posteriorly to receive the abdominal process from the second ventral segment. Lateral lobes (jugae) of head apically contiguous or nearly so-- 6

Metasternum devoid of smooth plate; posterior coxae contiguous or nearly so. Lateral lobe of head more rarely contiguous------ 9

6. Rostrum short, apex most commonly not extended beyond anterior notch of metasternal plate; basal segment not extended behind base of head. Metasternal plate extended anteriorly to at least the middle of the mesosternum and distinctly bifid anteriorly. In Cuban species humeral angles not at all prominent------*Edessa* Fab.

Rostrum long, extended onto venter of abdomen; basal segment surpassing bucculae and extended beyond base of head. Metasternal plate but slightly extended anteriorly on the mesosternum, obtusely concave before. Humeral angles prominent. Body less convex ventrally------ 7

7. Lateral margins of pronotum with several long teeth. Dorsal parts distinctly pilose------*Neopharnus* Van Duz.

Lateral margins of pronotum unarmed. Dorsal parts not pilose------ 8

8. Lateral margins of pronotum straight. Third segment of rostrum much longer than second. Second and third segments of antenna subequal-- ------*Praepharnus* n. g.

Lateral margins of pronotum more or less concavely sinuate. Second segment of antenna much shorter than third------*Pharnus* Stal.

9. Second ventral segment of abdomen produced anteriorly in a distinct spine or well defined tubercle------ 10

Second ventral segment of abdomen neither produced in a distinct spine nor definite tubercle------ 16

10. Spine of second ventral segment of abdomen long, surpassing posterior coxae------ 11

Second ventral segment of abdomen either armed with a shorter spine or only with a well defined tubercle------ 12

11. First antennal segment extended beyond margin of head. Connexivum of abdomen widely exposed and alternately banded with red and black. 18 mm. long----------*Vulsirea* Spin.

    First antennal segment not reaching to margin of head. Connexivum of abdomen not at all or narrowly exposed, unicolorous. 10 mm. long or less----------*Piezodorus* Fieb.

12. Lateral margins of pronotum very strongly, concavely sinuate; humeral angles bluntly prominent, rounded. First antennal segment surpassing margin of head. Ventral abdominal spine attaining middle of posterior coxae. Anterior tibiae distinctly, longitudinally sulcate---*Modicia* Stal.

    Lateral margins of pronotum most commonly nearly straight, if strongly convex then the humeral angles very acute or spinose---------- 13

13. Second ventral segment of abdomen armed with a distinct spine either projected between the posterior coxae or at least somewhat produced and subacute. Canal from odoriferous orifice long and attenuated, tapering to a very acute point reaching nearly as far as posterior lateral angle of mesopleurum. Cuban species pure green----------*Acrosternum* Fieb.

    Second ventral segment of abdomen elevated in a well defined obtuse tubercle---------- 14

14. Canal from odoriferous orifice short, not reaching to middle point of metapleurum; margins of canal elevated. Cuban species clear green----------*Nezara* A. and S.

    Canal from odoriferous orifice long and attenuated, acute apex reaching nearly as far as posterior lateral angles of mesopleurum---------- 15

15. Anterior tibia distinctly, longitudinally sulcate. Head across eyes wide, more than one-half the greatest diameter of the pronotum. Second segment of antenna much longer than one-half the length of fifth segment. Anterior margin of pronotum calloused. Lateral margin of pronotum, anteriorly, distinctly impressed----------*Pallantia* Stal.

    Anterior tibia obsoletely or not at all sulcate longitudinally. Head across eyes distinctly less than one-half the greatest diameter of the pronotum. Second segment of antenna about one-half the length of fifth segment. Anterior margin of pronotum not calloused----------*Banasa* Stal.

16. Head long, not immersed to eyes; tylus very acutely produced before the jugae. Humeral angles of pronotum very acutely or spinously produced. Odoriferous orifice not produced in an evident canal----*Proxys* A. and S.

    Head immersed to eyes; tylus neither acute nor much produced before jugae---------- 17

17. Odoriferous orifice terminating in a long, attenuated, acute canal, reaching halfway or more to margin of metapleurum---------- 18

    Odoriferous orifice either devoid of a canal or with a very short one not reaching halfway to margin of metapleurum---------- 19

18. Anterior and lateral margins of pronotum strongly impressed and reflexed or elevated. Pleura and venter very obsoletely punctate, shining. Brightly colored, red and black----------*Arocera* Spin.

    Anterior and lateral margins of pronotum scarcely impressed and not reflexed. Dorsal and ventral parts distinctly and profusely punctate, scarsely shining. Green species----------*Thyanta* Stal.

19. Odoriferous orifice set almost between the outer limits of the middle and posterior coxae, not terminating in a canal. Variegated species_____ _____*Murgantia* Stal.
Odoriferous orifice more remote from coxae, either terminating in a canal or merely auriculate exteriorly_____ 20
20. Bucculae rather short, extending as far as anterior margin of eyes; basal segment of rostrum much extended beyond bucculae. Basal segment of antenna extending beyond margin of head. Anterior and lateral margins of pronotum strongly impressed and reflexed. Canal from odoriferous orifice distinct but short, not reaching to middle of metasternum; abruptly terminating; margins calloused. Large red and black species_____ _____*Runibia* Stal.
Bucculae extending to base of head or very nearly so; basal segment of rostrum most commonly not much longer than bucculae. Anterior and lateral margins of pronotum not strongly impressed or reflexed. Odoriferous orifice auriculate exteriorly without a distinct canal_____ 21
21. Anterior tibia provided with a distinct, wide, longitudinal sulcus. Lateral margins of pronotum, at least anteriorly, denticulate or crenulate_____ _____*Euschistus* Dall.
Anterior tibia either devoid of a longitudinal sulcus or with a very narrow one_____ 22
22. First segment of rostrum not longer than bucculae. Head as long or very nearly as long as pronotum. Anterior disk of pronotum devoid of a smooth, calloused, yellow spot on each side_____*Solubea* Bergr.
First segment of rostrum somewhat longer than bucculae, the latter more elevated. Anterior disk of pronotum with a smooth, calloused, yellow spot on each side_____*Mormidea* A. and S.

Coriplatus depressus White

1842. White, Trans. Ent. Soc. Lond. III: 90.

"Cuba"—U. S. National Museum in the Uhler collection.

A new record, as this has hitherto been recorded only from British Guiana and Colombia. It is a very flattened hemipteron with a long head, in which the juga meet well before the tylus; the margins of the pronotum are provided with three large spines; the scutellum is spatulate, very long, reaching to the apex of the abdomen; the rostrum reaches, or nearly reaches, the apex of the abdomen, the venter of which is longitudinally sulcate.

Brochymena poeyi Guérin

1857. Guérin in La Sagra, Hist. Cuba, Ins. 365; Pl. XIII, Fig. 1.

Santiago de las Vegas (Barreto, Bruner, Acuña, and Otero); Casa Blanca (Bruner); Hoyo Colorado (Enamorado); Havana Prov. and Los Palacios (Betancourt, Acuña, and Barreto)—Est. Exp. Agron. "Cuba"—U. S. N. M. Also recorded by Gundlach from eastern Cuba.

Very clearly related to *arborea* but differs from that species by

having the truncated humeral angles slightly more projecting; teeth along the lateral margins of the pronotum fewer and more irregular; lateral margins of the head anteriorly more converging; subapical tooth less pronounced; bases of antennal segments 2–5 distinctly and widely pale ringed.

Mormidea pictiventris Stal

1862. Stal, Stett. Ent. Zeit. XXIII: 103.

Santiago de las Vegas (Cardín, Houser, and Bruner); Camagüey (Acuña); Palmira (Ballou); Nagua, Oriente (Bruner and Ballou); Las Animas, Sierra Rangel, Pinar del Rio (Cardín, Houser, and Bruner); El Cobre (Bruner); and Santa Bárbara, Isle of Pines (Bruner)—Est. Exp. Agron.

This is a common and widely distributed species from Mexico south through Central America to Colombia and the West Indies. It is a fuscous or fusco-ferruginous species on which the pale calloused markings are very conspicuous. The submarginal vittae of the scutellum extend posteriorly as far as the frena; the humeral angles are not at all prominent. It has much the appearance of *Mormidea lugens* Fab.

Mormidea cubrosa Dallas

1851. Dallas, List Hem. I: 247.

1872. *Mormidea sordidula* Stal, Enum. Hem. II: 21.

Santiago de las Vegas (Bruner); Nagua, Oriente (Bruner and Ballou); El Cobre, Oriente (Silvestri and Bruner); Jarahueca, Ote. (Bruner); Nueva Gerona, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron.

Stal described *sordidula* from Texas. Comparison of specimens from that state with those from Cuba and Jamaica shows that they are the same and answer to Dallas's description of the species from Jamaica. There is little question that Stal's name will have to be treated as a synonym. This is a rather small ferruginous species with the pale markings of the scutellum much reduced.

Mormidea angustata Stal

1862. Stal, Stett, Ent. Zeit. XXIII: 102.

Taco-Taco (Bruner, Acuña, and Ballou); Camagüey (Acuña); Puerta de Golpe, Pinar del Rio (Houser); Santa Fe and Columbia, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. McKinley, Columbia, and Nueva Gerona, Isle of Pines (Link)—U. S. N. M.

Described from Mexico and a fairly common species in Central America. Heidemann recorded it from the Isle of Pines. It is a

paler, more ferruginous punctate species than *pictiventris* Stal, and the submarginal calloused vittae of the scutellum extend as far as the frena; costal margins of the corium frequently reddish; humeri either spinose or angulated. There is some question as to whether or not this is a synonym of *M. scutellata* Westwood, which it may very well be.

Mormidea albisignis Stal

1872. Stal. Enum. Hem. II: 220.

Baracoa and Nagua, Oriente (Bruner and Ballou); Sierra Rangel, Pinar del Rio (Acuña and Bruner); Santiago de las Vegas (Bruner); "El Hospital," Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. La Milpa, Cienfuegos (Salt)—M. C. Z. Near Viñales—A. M. N. H. Baraguá (Plank); Cayamas (Schwarz)—U. S. N. M.

This species described from Cuba, measures 5–6 mm. in length. It resembles rather closely *M. ypsilon* (Linn.) in its general color and markings. Stal states that the second and third antennal segments are equally long, but in most of the specimens before us the second is slightly longer than the third segment. The humeri may be either rounded or spinose. Guérin lists *M. ypsilon* from Cuba but we have not seen it from that island.

KEY TO CUBAN SPECIES OF MORMIDEA

1. Apical angles of sixth abdominal segment of male and seventh of female plainly spinose; humeral angles variable, either spinose or obtuse 2
   Apical angles of sixth abdominal segment of male and seventh of female sometimes acute but not spinose; humeral angles always obtuse or rounded 3
2. Posterior margin of the male hypopygium strongly concavely sinuate in the middle; tylus not extended beyond apices of juga; membrane vitreous; submarginal calloused vittae of scutellum extended to frena, not incurved posteriorly; pleura each marked with a small black spot; venter nearly or quite immaculate; ferruginous punctate species with wide costal margins often reddish ..... *angustata* Stal.
   Posterior margin of the male hypopygium feebly concavely sinuate in the middle; tylus slightly extended beyond apices of juga; membrane embrowned; submarginal calloused vittae of the scutellum not as long as frena, these incurved, contiguous or nearly so about the middle of scutellum; beneath devoid of broad black stripes. Heavily infuscated species ..... *albisignis* Stal.
3. Posterior margin of the male hypopygium strongly concavely sinuate in the middle; membrane embrowned; submarginal calloused vittae of the scutellum extended as far as the frena; sternum black; pleura heavily and venter trivittate with fuscous. Fuscous or fusco-ferruginous species ..... *pictiventris* Stal.

Posterior margin of the male hypopygium feebly concavely sinuate in the middle; membrane vitreous; scutellum with a small, yellow, calloused spot in each basal angle which is rarely extended into vittae; marked beneath much as in preceding species. Ferrugino-griseous species------ ---------- *cubrosa* Stal.

Solubea pugnax (Fabricius)

1775. Fabricius, Syst. Entom. 704.

Los Palacios (Betancourt); Sierra Rangel, Pinar del Rio (Acuña and Bruner); Santiago de las Vegas, Havana Prov. (Plá, Barreto, and Bruner); Cunagua and Holguin, Oriente (Bruner); Palmira (Ballou); Bahía de Cochinos, Santa Clara (Bruner); Camagüey (Acuña); Baraguá, Camagüey Prov. (Stahl and Bruner); Holguin, Oriente Prov., and Manzanillo (Bruner and Ballou)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Cayamas (Schwarz)—U. S. N. M. San Carlos Est., Guantánamo and near Viñales—A. M. N. H.

A common species in Cuba and other West Indian Islands and differing in no respect from specimens taken in our southern states. Recorded from Cuba by Guérin as *Pentatoma (Mormidea?) typhoeus* Fab.

Solubea insularis (Stal)

1872. Stal, Enum. Hem. II: 22.

1857. *Pentatoma (Mormidea) geographica* Fabricius (var.), Guérin in La Sagra, Hist. Cuba Ins. 369.

1893. *Mormidea guerini* Lethierry and Severin, Cat. Gen. Hem. I: 123 (new name).

1902. *Oebalus insularis* var. *similis* Kuhlgatz, Berl. Ent. Zeit. 253.

Santiago de las Vegas (Bruner); Las Animas, Sierra Rangel, Pinar del Rio (Houser, Hutson, Cardín, Acuña, and Bruner); Hoyo Colorado, Havana Prov. (Enamorado and Bruner); Palmira, Santa Clara Prov. (Ballou); Nueva Gerona, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Jatibonico and Baraguá (Scaramuzza); Santiago de las Vegas (Cardín); Cayamas (Schwarz); Havana—U. S. N. M. Pinar del Rio—A. M. N. H.

Specimens of this same species are contained in the collection of the National Museum from Florida, Mexico, Honduras, Panamá, and Haití. In spite of its appearance it belongs to *Solubea* rather than *Mormidea* from the fact that the basal segment of the rostrum does not exceed the bucculae, the fore tibia are sulcate as in *S. pugnax* (Fab.), and the pronotum lacks the usual calloused spots. Some color varieties of it may be very easily confused with *Mormidea ypsilon* (Linn.) as was evidently the case with Guérin, who records that

species from Cuba. It varies in color from ferruginous to dark castaneous. The scutellum is particularly variable, being frequently with little or no evidence of calloused spots or more or less completely covered with smooth, calloused, yellow spots. This latter form Kuhlgatz described as var. *similis* from Colombia. The humeral angles are sometimes spinose. The hypopygium of the male has a distinct central lobe as noted by Stal. This is the species recorded by the senior author in his Florida List as *Mormidea guerini* Leth. and Sev. and is so treated by Blatchley in Heteroptera of Eastern North America.

Solubea linki (Heidemann)

1917. *Mormidea linki* Heidemann Ann. Carnegie Mus. XI: 351.

Calabazar, Havana Prov. (Bruner); Bahía de Cochinos, Santa Clara Prov. (Bruner); Baraguá, Camagüey Prov. (Stahl and Bruner); El Cobre and Manzanillo, Oriente Prov. (Ballou and Bruner); Los Indios and El Hospital, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. Columbia, Isle of Pines (Link); Havana and Cayamas (Schwarz); Baraguá (Stahl); 12 miles north of Santiago (Morrison)—U. S. N. M. Near Pinar del Rio—A. M. N. H.

This is much smaller than the other two species mentioned, in which the basal segment of the rostrum does not exceed the bucculae, and thus it is included in *Solubea* rather than in *Mormidea* where it was first placed by Heidemann. It differs from the other two species in that the anterior tibia is not sulcate. The humeral angles may be either angulated or spinose. It does not approach *Mormidea ypsilon* (Linn.) in structure or appearance as stated by Heidemann.

KEY TO CUBAN SPECIES OF SOLUBEA

1. Humeri armed with long, anteriorly directed spines; anterior tibia longitudinally sulcate; spiracles black; posterior margin of male hypopygium (ventral view) concave. Large species, 10–12 mm. ..... *pugnax* (Fab.).
Humeri either angled or shortly spinose; posterior margin of male hypopygium (ventral view) lobate in the center; smaller species, not over 8–9 mm. 2
2. Lateral margins of pronotum very lightly concavely arcuate; humeri either angled or spinose; anterior tibia longitudinally sulcate; spiracles not black; posterior margin of male hypopygium very strongly lobate in the center ..... *insularis* (Stal).
Lateral margins of pronotum strongly concavely arcuate and slightly crenulate; humeral angles shortly spinose; anterior tibia not longitudinally sulcate; spiracles black; posterior margin of male hypopygium much more feebly lobate in the center ..... *linki* (Heid.).

Euschistus acuminatus Walker

1867. Walker, Cat. Hem. Het. II: 246.

Nagua, Oriente Prov. (Bruner and Ballou) Taco Taco, Pinar del Rio Prov. (Ballou, Acuña, and Bruner); Santiago de las Vegas, Havana Prov. (Plá and Bruner), St. Tomás, Península de Zapata, Santa Clara Prov. (Bruner and Acuña); Camagüey, Camagüey Prov. (Acuña)—Est. Exp. Agron. Central Jaronú (Scaramuzza); "Cuba" (3 specimens labeled *E. thoracicus* Dallas var. by Uhler)—U. S. N. M.

This species was determined as *E. thoracicus* Dallas by Uhler and Gundlach but the specimens agree better with Walker's *acuminatus* described from San Domingo. "Thorax with a black hook-shaped mark on each side in front and with a black band between the spines which are black and slightly ascending, etc.", will serve to identify this species.

Euschistus crenator (Fabricius)

Plate XXV, Fig. 2

1794. Fabricius, Ent. Syst. IV: 101.

Viñales, Pinar del Rio Prov. (Bruner)—Est. Exp. Agron.

This species has been listed from Cuba as well as from other West Indian Islands. As it can be distinguished from *bifibulus* chiefly by comparative differences it is often confused with it. We have seen specimens from Dominica, Grenada, St. Croix, Jamaica, and Puerto Rico in the National Museum collection. The male hypopygium or genital segment in this species is narrower, about twice as wide as long, and much more feebly excavate behind than in *bifibulus* and the sixth abdominal segment with its lateral posterior angles more nearly form a right angle. The teeth along the lateral margins of the pronotum are more evident and usually black. The humeral angles are variable. There is little or no evidence of a transverse pale streak on the pronotum. *E. pustulatus* P. B. and *obscurus* (male) Pal. Beauv. are synonyms. It appears to be a rare insect in Cuba, as it is represented by only one specimen in the material before us.

Euschistus bifibulus (Palisot de Beauvois)

Plate XXV, Fig. 3

1805. Palisot de Beauvois, Ins. Afr. Amer. 148; Pl. X, Fig. 5.

Santiago de las Vegas on Egg Plant and *Solanum torvum* (Cardín, Hutson, Houser, and Bruner); Hoyo Colorado (Enamorado and Bruner); Punta Brava-Havana Prov., Viñales and Sierra Rangel, Pinar del Rio Prov. (Bruner and Acuña); Palmira, Santa Clara

Prov. (Ballou); Camagüey, Camagüey Prov. (Acuña); Seboruco (Bruner); Nagua (Ballou and Bruner) in Oriente Prov.—Est. Exp. Agron.

The male of this common species is easily differentiated from *crenator* (Fab.) by the hypopygium being decidedly wider than long, broadly and deeply excavate behind; sixth abdominal segment with the posterior lateral angles acutely spinose; female with the seventh abdominal segment extended in acutely spinose projections; humeral angles generally produced, acute or spinose; pronotum with a more or less evident pale impunctate streak running across the pronotum between the humeral angles; teeth along the lateral margin finer and in most cases pale. The size varies from 8–11 mm. Gundlach records this as *Euschistus bifibulus,* No. 341, in his collection.

Euschistus obscurus (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. 149; Pl. 10, Fig. 9 (♀ only).

1907. *Euschistus ursus* Van Duzee, Bull. Buffalo Soc. Nat. Sci. VIII: 8.

1926. *Euschistus bifibulus* Blatchley (nec Pal. B.), Heteropt. E. No. Amer. 140.

1927. *Euscristus atromaculosus* Barber, Bull. Bklyn. Ent. Soc. XXII: 241.

Camagüey, Camagüey Prov. (Acuña)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Described from San Domingo. Van Duzee described it as *ursus* from Jamaica and Haiti. Under the latter name Heidemann records it from the Isle of Pines. *E. atromaculosus* was described from Florida. Guérin recorded it from Cuba as *obscurus* and Gundlach as *crenator.* The anterior face of the pronotum is heavily infuscated, with a distinct, transverse, pale streak between the humeri; the corium has a number of scattered small black spots which are quite characteristic of the species and readily distinguish it from *crenator* or *bifibulus.*

Euschistus crassus Dallas

1851. Dallas, List Hem. I: 205.

Santiago de las Vegas, Havana Prov. (Otero); El Cobre and Omaja, Oriente Prov. (Bruner); Sto. Tomás, Península de Zapata, Santa Clara Prov. (Bruner)—Est. Exp. Agron. 12½ k. south of Pinar del Rio and 7 k. north of Viñales—A. M. N. H.

Although all of the specimens before us are considerably smaller (7–8 mm.) than specimens from Florida, which will run 10–11.5

mm. long, we can find no structural differences to warrant its description as new. It is very convex below with the short humeral spines directed somewhat obliquely forward; a more or less evident calloused pale line runs across the disk between the humeral angles.

KEY TO CUBAN SPECIES OF EUSCHISTUS

1. Male hypopygium with posterior margin (ventral view) broadly and deeply excavate; posterior apical angle of sixth abdominal segment acutely spinose; apical angles of the seventh segment in female attenuate, acute; a more or less evident pale streak across the pronotum between the humeral angles ..... *bifibulus* (Pal. B.)

   Male hypopygium either subtruncate posteriorly or feebly excavate or lightly lobate in the center 2

2. Male hypopygium with posterior margin nearly truncate and with a slight median lobe; body beneath strongly convex, ferruginous punctate; scutellum rather broad at apex ..... *crassus* Dall.

   Male hypopygium feebly excavate posteriorly; body moderately convex beneath with concolorous punctures; scutellum narrow at apex 3

3. Posterior lateral angles of the sixth abdominal segment in the male and seventh in the female produced, spinose; humeri strongly spinose. A few marks in front and an irregular line across the posterior disk black ..... *acuminatus* Walker.

   Posterior lateral angles of the sixth segment in the male acute, not produced or spinose; pronotum without black fascia 4

4. Male hypopygium with lateral margins converging posteriorly; median posterior sinus more obvious; posterior margin of seventh abdominal segment of female obliquely truncate, apical angles not attenuated or produced; pronotum without pale transverse fascia between the humeral angles; scutellum and corium with scattered white spots ..... *crenator* (Fab.).

   Male hypopygium with lateral margins symmetrically rounded, not converging posteriorly; posterior angles of seventh abdominal segment of female acuminate and produced; a pale streak across the posterior disk of the pronotum; corium with scattered black spots ..... *obscurus* (Pal. B.).

Proxys punctulatus (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. 188; Pl. XI, Fig 9.

Santiago de las Vegas, Havana Prov. (Barreto and Bruner); Camagüey, Camagüey Prov. (Acuña), Taco Taco (Bruner, Acuña, and Ballou); Nagua, Oriente Prov. (Bruner and Ballou); Isle of Pines (Ballou)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Baraguá (Scaramuzza)—U. S. N. M.

This widely distributed species is readily distinguished from the other members of the genus by having the apices of all femora as well as the bases and apices of all tibiae black.

Thyanta perditor (Fabricius)

Plate XXV, Fig. 4

1794. Fabricius, Ent. Syst. IV: 102.

Viñales, Pinar del Rio Prov. (Bruner and Acuña); Santiago de las Vegas (Acuña) and Playa de Marianao (Bruner) Havana Prov.; Palmira, Santa Clara Prov. (Ballou); El Cobre, Oriente Prov. (Bruner); Camagüey, Camagüey Prov. (Acuña); Isle of Pines (Bruner)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. Cayamas (Schwarz); "Cuba" (Uhler coll.)—U. S. N. M.

This is the largest and commonest species of the genus occurring in the West Indies, 10–13 mm. long, usually with a distinct purplish band across the pronotum between the humeri and two small black spots on the anterior face. The humeral angles are drawn out into acute spines directed somewhat anteriorly; lateral margins concavely arcuate to the apices of the spines. Posterior and anterior angles of each connexival incisure with a minute black spot.

Thyanta cubensis new species

Plate XXV, Figs. 4 and 5

Green with the narrow lateral margin of the pronotum yellow; narrow lateral margin of connexivum orange with a minute, black spot at the outer apical angle of segments 2–5, these more distinct below. Antennae with first two and base of third segments pale green, the remainder infuscated.

Head about one-sixth wider than long, in general shape and character of punctation not differing from *perditor*. Second segment of antennae slightly shorter than third. Apex of rostrum reaching to the middle of the second ventral abdominal segment. Pronotum two and two-thirds wider than long; lateral margin irregularly serrate, straight from anterior angle to near base of humeral spine whence it turns rather more abruptly than in *perditor* to form the front face of the spine; the latter more slender and directed more anteriorly than in *perditor;* the two black spots in the cicatrices of the anterior disk and transverse purple fascia between humeral angles lacking; posterior disk behind the cicatrices closely punctate between transverse irregular ridges, giving a more characteristic rugose appearance to that part than in *perditor*. Scutellum slightly longer than wide, distinctly rugulose anteriorly and closely punctate between the rugae. Hemielytra closely and evenly punctate, punctures coarser and shallower than on scutellum, with scattered pale calloused spots. Membrane clear and often faintly spotted. Venter rather closely punctate on the sides, nearly smooth, very sparsely punctate in the center; outer apical angle of sixth segment in the male more obtuse angled than in *perditor*, apical angles of the connexival segments tipped with black; sinus of the male hypopygium narrower, with the cleft in the central lobe much shorter than the lateral rounded lobes. Length 7–9 mm.

Type, male: Camagüey, July 20, 1923 (J. Acuña)—U. S. N. M.
Paratypes, males: 5 Camagüey, July 20, 30, 31, 1923 (J. Acuña);

1 Isle of Pines, Feb. 1923 (C. H. Ballou); 1 Sta. Bárbara, Isle of Pines, Mch. 15, 1923 (S. C. Bruner); 1 Colonia, Cayo Romona, Sta. Clara Prov. (S. C. Bruner)—Est. Exp. Agron. 2 Cayamas (E. A. Schwarz); 1 "Cuba" (Uhler coll.)—U. S. N. M. 1 Zaza d. Media, Sept. 30, 1913; 1 Santiago, Oct. 2–10, 1913 (F. E. Lutz)—A. M. N. H. *Paratypes, females:* 3 Camagüey, July 21 & 30, 1923 (J. Acuña)—Est. Exp. Agron. 1 Cayamas (E. A. Schwarz)—U. S. N. M. 1 Zaza d. Media, Sept. 30, 1913 (F. E. Lutz)—A. M. N. H. Cat. No. 44045, U. S. N. M.

Very closely related to *perditor* from which it can be distinguished, aside from its smaller size, by the narrower pronotum with its straight lateral margin; more slender and more anteriorly directed humeral spines; and absence of black anterior discal spots and transverse purple-red band of the pronotum. While *perditor* has a minute black spot at the base and apex of each connexival segment, there is in this species but a single spot at each apical angle.

Thyanta casta Stal

1862. Stal, Stett. Ent. Zeit. XXIII: 104.

Jarahueca, Oriente Prov. (Bruner)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Compared to the other West Indian species this is more depressed; humeral angles of pronotum somewhat prominent and forming nearly a right angle; the lateral margins straight; second segment of antennae subequal to or slightly longer than the third; pronotum and base of scutellum transversely rugose; corium less distinctly and more shallowly punctate than in *custator*. The size varies from 8 to 9 mm. long.

Thyanta antiguensis (Westwood)

1837. Westwood, Hope Cat. I: 36.

Santiago de las Vegas (Cardín, Hutson, Houser, and Acuña) and Playa de Marianao (Bruner) Havana Prov.; Baraguá (Stahl and Bruner) and Camagüey (Acuña) Camagüey Prov.—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

A common species throughout the West Indies. It is much smaller than the two previous species with the humeral angles not at all prominent and usually bluntly rounded; most commonly with a transverse purplish-red band between the humeri, although sometimes entirely green; second segment of the antennae generally longer than the third; apical angles of the connexival segments black; posterior mar-

gin of the male hypopygium broadly excavated (ventral view), without a median lobe.

Thyanta rugulosa (Say)

1831. Say, New Harm. Ind.; Compl. Writ. I: 319 (1859).

Stal and Uhler record this species from Cuba but we have not seen it from that island. This is one of the smaller species, scarcely larger than *antiguensis* (Westw.), measuring 5–7 mm. long. It has no purplish-red band between the humeri and the odoriferous canal is short, much shorter than the distance from its apex to the lateral margins of the metapleurum; the posterior margin of the male hypopygium is not lobate but lightly notched in the center.

KEY TO CUBAN SPECIES OF THYANTA

1. Humeral angles of pronotum acute, spinose; male hypopygium with a central lobe, cleft in the center 2
   Humeral angles not spinose; male hypopygium without central lobe 3
2. Lateral margins of pronotum straight, without either black discal spots or transverse purple-red band; connexival incisures with minute black spot at apical angles of segments only ..... *cubensis* n. sp.
   Lateral margins of pronotum concavely arcuate from anterior margin to apex of spine; anterior disk with two small black spots and usually a transverse purple-red band between the humeri; connexival incisures with two minute black spots ..... *perditor* (Fab.).
3. Second and third segments of antenna either nearly equal or second segment shorter than third; body more depressed; subshining; humeri usually angled. Species at least 8 mm. long = ? *maculatus* (Fab.)* ..... *casta* Stal.
   Second segment of antenna distinctly longer than third; body not depressed; humeral angles not prominent, rounded. Small species 6–7 mm. long 4
4. Canal from odoriferous orifice shorter than the distance from its apex to the lateral margin of the pleurum; posterior margin of the male hypopygium with a small notch in the center ..... *rugulosa* (Say).
   Canal from odoriferous orifice distinctly longer than the distance from its apex to the lateral margin of the pleurum; posterior margin of the male hypopygium entire ..... *antiguensis* (Westw.).

Loxa pallida Van Duzee (?)

1909. Van Duzee, Bull. Buff. Soc. Nat. Sci. IX: 156

Santiago de las Vegas (Barreto and Acuña); La Lisa, Havana (Bruner)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

This was described from Jamaica: Horvath records it also from

* We have not been able to find any structural differences between *Thyanta maculata* Fab. and *T. casta* Stal and suspect that the latter is an unmarked form of *maculata*, in which case Fabricius' name would take precedence. Typically colored specimens of *T. maculata* (Teste Stal, Hem. Fab. I, 29, 1868) have the apical parts of the terminal three antennal segments, tylus, lateral angles and two spots on posterior disk of pronotum, and apex of scutellum fuscosubsanguineous. Specimens of both the marked and unmarked forms have been collected at El Cano, by S. C. Bruner and A. Otero.

Cuba. We have five specimens of what we take to be this species from Cuba and one from Jamaica. It is rather closely related to the species *flavicollis* as described and depicted by Drury but not that of Horvath 1925. Besides being smaller and relatively narrower, the lateral margins of the head are nearly straight and the longitudinal ridges fairly distinct. The antennae are pale, unicolorous, with the second and third segments nearly equal or the second a little shorter than the third. In two of the specimens the small white calloused spots are quite distinct on the surface of the pronotum, scutellum, and corium. The apex of the rostrum reaches the middle of the second ventral segment of the abdomen.

Loxa planifrons new species

Plate XXV, Figs. 6 and 7

Color yellow-green with punctures mostly concolorous; narrow lateral edge of head, pronotum, marginal teeth, humeral spines, and costal margins at base yellowish; connexivum and venter yellowish-green; antennae, rostrum, and legs pale yellowish-white; membrane vitreous, faintly speckled with green.

Head with lateral margins straight; juga acuminate, almost contiguous before apex of tylus, devoid of longitudinal rugae and punctures; transverse rugae fairly distinct. Antennae with basal segment rather short, not reaching to apex of head, second and third segments nearly equal. Rostrum with the apex reaching to the middle of the third ventral segment of the abdomen. Pronotum with the surface behind cicatrices densely covered with distinct, short, irregular rugae; obsoletely and finely punctate between the rugae, punctures often concolorous; lateral margin gently concavely arcuate from anterior margin to apex of humeral spine; margin armed with 15–17 short, blunt teeth; submargin without a broad band of distinctly colored punctures, so characteristic of most of the species, surface rugose to base of teeth; humeral spines slightly turned upwards, relatively short, subequal to or a little shorter than the distance between the eyes. Scutellum not strongly elevated on the basal disk, which is distinctly rugose, laterally and apically rather sparsely punctate. Hemielytra finely, concolorously punctate, more closely punctate towards outer apical angles. Connexivum coarsely, concolorously punctate. Opaque area of the metapleurum non-punctate, distinctly rugose. Venter very sparsely long pilose, smooth in the center, either side of which the surface is distinctly rugose and finely wrinkled; submargins obsoletely punctate. Sixth ventral segment of the male in the mid-line about twice as long as the three preceding segments combined (50: 23); spines at the outer apical angles of fifth segment slender, acute, and extending to or beyond the posterior margin of the hypopygium. Length 19 mm.; humeral diameter 13 mm.

Type, male: Santiago de las Vegas, Cuba, Sept. 5, 1923 (J. Acuña)—Est. Exp. Agron. *Paratype, male:* 1 Santurce, Puerto Rico, Aug. 1, 1925 (Cooley and Gay)—U. S. N. M. *Paratypes, females:* 1 Santiago de las Vegas, Cuba, Sept. 2, 1923 (J. Acuña)—Est. Exp. Agron. 1 Pt. Cangrejos, Puerto Rico, Feb. 22, 1922 (G. N. Wolcott); 1 Santurce, Puerto Rico, Aug. 1, 1925 (Cooley and Gay)—

U. S. N. M. 1 Mameyes, Puerto Rico, Feb. 17, 1925 L. B. Woodruff —A. M. N. H. Cat. No. 44046. U. S. N. M.

This species may be readily distinguished by the absence of the longitudinal ridges on the head and by the distinct rugosity of the venter.

Murgantia histrionica (Hahn)

1834. Hahn, Wanz. Ins. II: 116; Fig. 196.

Almendares River, Havana Prov., 1917 Cardín on *Cleome pentaphylla*: Marianao and Víbora Boucié —Est. Exp. Agron. Havana (Knab and Morrison)—U. S. N. M.

The destructive harlequin cabbage bug seems to be well established in Cuba, at least about Havana. So far as our records go it has not hitherto been reported from the island.

Arocera protea var. **affinis** Distant

1880. Distant, Biol. Cent. Amer. Rhynch. I: 73; Tab. VII, Fig. 19.

Mountains near Taco Taco (Brunner, Acuña, and Ballou) and Sierra Rangel, Pinar del Río Prov. Brother Roberto —Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

These correspond exactly with Distant's description and figure. A character not mentioned by the author is the fuliginous color of the membrane with its apical margin broadly pale. This species was recorded by Gundlach from Mte. Líbano, Oriente Province. The two specimens in the National Museum were wrongly determined by Uhler as *Runibia proxima* Dallas.

Runibia proxima (Dallas)

1851. Dallas, List Hem. I: 255.

Although we have not seen this from Cuba, Gundlach records it from both the eastern and western part of the island. A specimen from Jamaica is in the National Museum collection. It is much larger than the preceding, bright red, closely and finely punctate, with two black spots on pronotum, scutellum, and corium; apical angles of connexival segments distinctly produced and marked with black. Membrane black, margined with white.

Vulsirea violacea (Fabricius)

1803. Fabricius, Syst. Rhyng. 167.

Nueva Gerona, Isle of Pines (Ballou)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M. Gundlach records it from Matanzas and Santa Clara Province (Cienfuegos). A number of color varieties are

recognized. It is about the size of the preceding (14–16 mm.), mostly dark purple in color, with a broad red band, notched behind, across the disk of pronotum, a Y-shaped red mark on the scutellum and the connexivum banded with red and black. Apical angles of the connexival segments scarcely produced.

Nezara viridula (Linnaeus)

1758. Linnaeus, Syst. Nat. 444.

Santiago de las Vegas, Havana Prov. (Gómez de la Maza, Houser, Barreto, and Bruner); Camagüey, Camagüey Prov. (Acuña); Maisí (Acuña) and Nagua, Oriente Prov. (Bruner and Ballou); Viñales, Pinar del Río Prov. (Acuña)—Est. Exp. Agron. Soledad (Myers and Salt); Mina Carlota, Trinidad Mts. (Myers)—M. C. Z. Santiago de las Vegas (Cardín)—U. S. N. M.

A widely distributed species throughout most of the warmer parts of the world and quite common in the West Indies where, as elsewhere, it is of considerable economic importance. It can be distinguished from the following species by the character of the male hypopygium which in this species has a wide deep sinus, obtusely rounded in the center between the rounded lateral lobes and by the very short odoriferous canal.

Acrosternum marginatum (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. 147; Pl. X, Fig. 1.

Santiago de las Vegas (Hutson) and Punta Brava (Acuña) in Havana Prov.; Camagüey, Camagüey Prov. (Acuña); Santiago de Cuba, Oriente Prov. (Silvestri and Bruner); Viñales (Acuña) and Caibaguan, Sierre Rangel, (Acuña and Bruner) Pinar del Río Prov. —Est. Exp. Agron. Santiago de las Vegas (Cardín)—U. S. N. M.

The male hypopygium has a wide shallow sinus obtusely angled between the obtusely angulated lateral lobes. The margins of head, pronotum, corium anteriorly, and connexivum are orange yellow. The latter has a minute black spot at the apices of the segments which is also found in the preceding species.

Nezara nitida (Westwood)?

1837. Westwood, Hope Cat. I: 33.

1836. *Pentatoma marginale* Herrich-Schaeffer, Wanz. Ins. III: 96, Fig. 320 (Preocc.).

Recorded from Brazil and Argentine. A single specimen, No. 63, in the Gundlach collection is labeled "*Nezara marginale* H. S." It agrees with Herrich-Schaeffer's description and figure with the ex-

ception of the head which is pale (faded?). It is about the size of small specimens of *Acrosternum marginata* P. B. but is somewhat narrower with less prominent lateral angles of pronotum, and the head is shorter and broader. As to color, it is dark greenish, with a broad pale pinkish border around the body, narrower on costal margin of hemielytra and broader in front on the pronotum; a broad similarly colored median vitta runs from the anterior border of the thorax to the apex of the scutellum; the head is pale. We have followed Gundlach's determination of this specimen with considerable doubt, but owing to the fact that the collection is contained in a sealed glass-topped box it is impossible to remove it for close study. Possibly the specimen is not from Cuba, although Gundlach lists the species in his manuscript notebook as represented in both his collection and that of Felipe Poey, but does not indicate the locality from which it was obtained as was his custom.

Banasa subrufescens (Walker)

1867. Walker, Cat. Hem. Het. II: 290.

1872. *Banasa varians* Stal, Enum. Hem. II: 43.

1851. ? *Rhaphigaster antica* Dallas, List Hem. I: 283.

Soledad and Mina Carlota, Trinidad Mts. (Myers)—M. C. Z. "Cuba" (Uhler coll.)—U. S. N. M. Fermina, Matanzas Prov. (Gundlach coll.).

The Cuban specimens answer perfectly to Stal's original description of *dimidiatus* from Brazil, which later, owing to the preoccupation of the name, he changed to *varians*. Distant, in Biologia Centrali Americana, figures *varians* and places two of Walker's species as synonyms, extending its range to Panama, Guatemala, Mexico, and the West Indies. Kirkaldy in his catalogue of 1909 places these several names as synonyms of *subrufescens* Walker as it antedates Stal's name. It seems to the authors that *Rhaphigaster antica* Dallas 1851 may very well be the same species, in which case it would take precedence over Walker's name. It bears a rather close superficial resemblance to *dimidiata* Say, but it is less convex both dorsally and ventrally, with a shorter and more narrowly rounded head in front as well as less disparity in the length of the second and third segments of the antennae.

Banasa punctatissima new species
Plate XXV, Fig. 8

Not highly polished but somewhat shining; rather closely punctate. Color above green with lateral margins of pronotum narrowly yellow; costal margin

of hemielytra anteriorly narrowly whitish; beneath yellowish; legs and antennae pale green with apical half of third and all of fourth and fifth segments of the latter darker.

Head short, about one-sixth wider than long; lateral margins strongly, concavely arcuate before eyes; evenly rounded in front with the three lobes equal; surface roughly, coarsely, but rather sparingly punctate; lateral lobes plainly wrinkled transversely. Antennae with third segment two-fifths longer than second and equal to fourth; fifth segment only a little longer. Rostrum extending to the hind coxae. Pronotum two and one-half times wider than long (13:5), rather closely and evenly punctate; anterior submargin not depressed and provided with two or three irregular rows of punctures; lateral margin straight, smooth, calloused, scarcely reflexed; humeral angles somewhat projected, rounded. Scutellum unicolorous, about as long as wide, somewhat more sparingly punctate than the pronotum except at apex. Hemielytra rather coarsely but sparingly and evenly punctate. Membrane hyaline. Connexival margins pale green, a very slight, almost obsolete fuscous spot at the outer apical angle of each segment. Venter roughly, coarsely, and rather sparsely punctate on the sides. The male hypopygium, seen from below, is cut out in a very deep V-shaped sinus, rounded at base; the much depressed central portion occupying the base of the sinus gently rounded posteriorly; lateral angles on either side of the sinus obtusely rounded and densely setose there and along the inner margins of the sinus. Length 9.5 mm.

Type, male: Sto. Tomás, Península de Zapata, May 5–9, 1927 (Bruner and Acuña)—Est. Exp. Agron. *Paratypes, males:* Two with same data as type; Hoyo Colorado, Havana Prov. Oct. 7, 1926. *Paratypes, females:* Two with same data as type—Est. Exp. Agron. Cat. No. 44047, U. S. N. M.

This species is most closely related to *lenticularis* Uhler but is readily distinguished from that species besides its color by the much denser punctation on the dorsal parts. The genital segment (hypopygium) of the male is sometimes infuscated.

Pallantia macula (Dallas)

1851. Dallas, List Hem. I:284.

Hoyo Colorado, Havana Prov. (Bruner); El Cobre, Oriente Prov. (Bruner)—Est. Exp. Agron. Cayamas (Schwarz)—U. S. N. M.

This is the first report of this species from Cuba. Stal lists it from Brazil and Mexico. Distant in figuring the species in the Biologia adds Guatemala. It has much the appearance of a *Banasa* but its short head and sulcate tibia will differentiate it.

Piezodorus guildinii (Westwood)

1837. Westwood, Hope Cat. I:31.

Santiago de las Vegas, Havana Prov. (Acuña); Viñales, Pinar del Río Prov. (Bruner and Acuña); Nagua (Bruner and Ballou)

and El Cobre (Bruner) Oriente Prov.—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

A common species throughout the West Indies and most of the Neotropical regions.

Piezodorus tinctus Distant

1890. Distant, Biol. Cent. Amer. Rhynch. I: 341; Tab. 31, Fig. 22.

Camagüey, Camagüey Prov. (Acuña); El Cano and Playade Baracoa, Havana Prov. (Bruner); Viñales, Pinar del Río Prov. on *Pithecolobium arboreum* Linn. (Bruner)—Est. Exp. Agron. Cayamas (Schwarz)—U. S. N. M.

Distant described this from Panama and "Antilles." In the National Museum collection is a specimen from San Jacinto, Salvador. It is a broader form than the preceding species with a longer head and a much longer ventral spine which is projected forward to the middle of the mesosternum; the latter is longitudinally sulcate, not carinate; the apical angles of the connexival segments are more acutely prominent and the spiracles are not black-rimmed.

Modicia sexlineata Stal

1872. Stal, Enum. Hem. II: 46.

Sierra Maestra Mts. and Nagua, Oriente Prov. (Bruner and Ballou); Sierra Rangel, Pinar del Río Prov. (Bruner, Acuña, and Ballou)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Described from Cuba and apparently confined to that island. It has much the appearance of a *Podisus* and was erroneously labeled *Podisus politus* Uhl. (MS. name), while the above name was wrongly applied to *Pallantia macula* in the Gundlach collection. It is ochraceous, closely punctate with ferruginous, the punctures arranged in short, irregular, transverse rows on the pronotum and in six longitudinal rows on the head; the humeral angles are produced and subacute; the ventral spine is quite long and stout. The posterior femora of the male are distinctly incrassate and provided behind with a row of stout spines.

Arvelius albopunctatus (Degeer)

1773. Degeer, Mem. III: 331; Pl. 34, Fig. 6.

Santiago de las Vegas, Havana Prov. and Taco Taco, Pinar del Río (Bruner and Ballou); Herradura, Pinar del Río (Horne); Santo Tomás; Península de Zapata, Santa Clara Prov. (Bruner and Acuña)—Est. Exp. Agron. Upper Yara Valley (Scaramuzza); "Cuba" (Uhler coll.)—U. S. N. M.

A widely distributed species through the West Indies, Neotropical

regions, and southern part of the United States. Its pale, slightly green color, scattered white pustules of the corium, acutely pointed juga, and humeral angles, the latter turned somewhat anteriorly, will serve to distinguish this species.

Pharnus inconspicuus Herrich-Schaeffer

1840. Herrich-Schaeffer, Wanz. Ins. V: 102, Fig. 553.

Camagüey (Acuña)—Est. Exp. Agron.

Three specimens, two males and a female from the above locality are quite distinct from *insulicola.* The humeral angle is produced into a narrowly rounded lobe much more projecting than in that species and the lateral posterior angles of the connexival segments are more produced; the rostrum is much shorter, usually reaching only to the middle of the venter.

Pharnus insulicola Kirkaldy

1857. *Pentatoma (Mecistorhinus) variegata* Guérin, La Sagra Hist. de Cuba, Ins. 366 (Preocc.).

1909. *Pharmus insulicola* Kirkaldy, Cat. Cim. I: 151 (new name).

Camagüey (Acuña); Omaja, Oriente Prov. (Bruner)—Est. Exp. Agron. Soledad (Salt)—M. C. Z. "Cuba" (Uhler coll.)—U. S. N. M.

This is a relatively narrower species in which the humeral angles are scarcely prominent; lateral margins of pronotum more nearly straight; rostrum reaching nearly to the end of the abdomen, and apical angles of the connexival segments not projected.

Neopharnus fimbriatus Van Duzee

1910. Van Duzee, Trans. Amer. Ent. Soc. XXXVI: 73.

Nagua, Oriente (Bruner and Ballou)—Est. Exp. Agron.

Described from Florida. The single male specimen we determined with some doubt. It has a very strong resemblance to *Pharnus inconspicuus* but the presence of a few prominent marginal spines or teeth on the pronotum and its more evident pilosity differentiate it.

Praepharnus new genus

Body depressed. Head wider than long; apices of the juga obtuse, a little longer than tylus and nearly contiguous before it; lateral margins concave a short distance before eyes; ocelli much more remote from each other than from the eyes; bucculae anteriorly forming a right angle, gradually evanescent posteriorly, not reaching beyond anterior margin of eyes. Antennae with basal segment just reaching to apex of head; second segment one-third shorter than third. Rostrum long and slender, its apex reaching to or slightly behind the posterior margin of the metasternal plate; basal segment extending beyond the

bucculae and reaching base of head; second segment a little longer than basal; third segment longest of all, one-third longer than second; fourth segment less than one-half the length of third. Pronotum over twice as wide as long; humeral angles strongly projected, forming nearly a right angle but narrowly rounded at apices; lateral margins carinate. Mesosternum broadly swollen, smooth, longitudinally carinate, carina gradually expanding anteriorly and there more elevated, extending slightly beyond anterior margin of mesosternum. Metasternal plate short and wide; anterior horns short and subacute, extending anteriorly but a short distance on the mesosternum; anterior sinus between the horns very obtusely angled; sinus at posterior margin broadly rounded; two posterior horns quite as long as anterior horns, their apices narrowly rounded. Groove from the odoriferous orifice long, acuminate, acute, much longer than the distance from its apex to the lateral margin of the metapleurum, not terminating in a long tapering ridge. Scutellum much longer than wide, apically somewhat narrowed. Hemielytra strongly punctate; frena extending well beyond middle of scutellum. Membrane provided with seven or eight simple veins which are not complete to posterior margin. Apical angles of connexival segments slightly prominent. Venter armed in front (second segment) with a flattened tubercle bluntly rounded anteriorly and fitting into the posterior sinus of the metasternal plate; a broad, bluntly rounded keel through the center. Tibia sulcate.

Type: Praepharnus prominulus n. sp.

More closely related to the genus *Pharnus* than to *Edessa* because of the presence of the mesosternal carina, shape of the metasternal plate, long, slender rostrum, as well as the depressed form of the body. From *Pharnus* it differs by having the second segment of antennae relatively longer, third segment of rostrum much longer than second, straight lateral margins of pronotum, etc.

Praepharnus prominulus new species

Plate XXV, Fig. 9 Plate XXVI Figs. 10 and 11

Head, pronotum, scutellum, and ventral parts olive green, in part coarsely punctate with black; small, smooth area between eyes and ocelli pale yellow-green; ocelli red; narrow lateral margins of pronotum yellow; hemielytra yellow-testaceous, heavily fusco-punctate; base and apical angles of connexical segments 2–6 black; mesosternal carina and metasternal plate pale yellow-white; venter with a few regularly arranged black spots; antennae pale; legs testaceous, paler towards base; femora preapically marked or punctate with fuscous; tibiae with a prebasal and preapical fuscous band. Head one-sixth wider than long (6: 5); lateral lobes (juga) bluntly rounded in front, projecting but little before apex of tylus but not contiguous before it; lateral margins suddenly contracted a short distance before eyes, thence nearly parallel, symmetrically rounded at anterior third; surface sparsely and irregularly punctate with black; ocelli red; a smooth paler area between eyes and ocelli. Bucculae higher in front, forming a right angle, gradually diminishing posteriorly and disappearing on a line with anterior margin of eyes. Antennae (last segment missing) pale, finely pilose, basal segment just reaching apex of head; second segment one-third shorter than third which in turn is about one-third shorter than fourth. Rostrum with the first and second segments more incrassate, subequal; third segment

one-third longer than second and fully twice as long as fourth. Pronotum about three times as wide as long; lateral margins straight, entire, impressed or carinate, and sparsely punctate with black; humeral angles somewhat projecting, nearly forming a right angle but narrowly rounded at apices; lightly concave behind humeri; dorsal surface coarsely and rather closely punctate with fuscous, except anteriorly and along submargins; with an obsolete median longitudinal carina; cicatrices somewhat elevated and provided with a few punctures. Scutellum but little longer than wide (25: 21); apex narrowly rounded; sparsely, irregularly, and coarsely punctate with black; a fuscous spot midway on either side of middle. Hemielytra more closely and finely punctate than scutellum; subcostal region nearly one-half as wide as corium. Membrane fuliginous, provided with three or four elongate, clear spaces between the simple veins which do not attain the margin. Segments of the connexivum coarsely and closely punctate anteriorly and posteriorly, depressed in the middle; apical angles slightly projecting. . Meso- and metapleura as well as the venter almost impunctate but provided with a few small black spots. Elevated part of the mesosternum smooth, bounded on each side by a calloused, yellow, arcuate fascia; longitudinally carinate, carina highest and widest in front, projecting a little between the anterior coxae. Metasternal plate as described in the diagnosis of the genus. Groove from the odoriferous orifice long, open for its entire length, three times as long as the distance from its apex to the lateral margin of the metapleurum. Venter on each side provided with three rows of small black spots, one near each spiracle, obliquely back of these midway in the segments is the middle row, the inner or third row consisting of four spots, each situated on the incisures between segments 3–6; longitudinal carina wide, rounded and slightly elevated. Length 11–14 mm.; humeral diameter 7–7.5 mm.

Type, male: Camagüey, July 23, 1923 (J. Acuña)—Est. Exp. Agron. *Paratypes, females:* 1 Camagüey, July 21, 1923 (J. Acuña) —Est. Exp. Agron.; 1 North of Viñales, Sept. 16–22, 1913 (F. E. Lutz)—A. M. N. H. Cat. No. 44048, U. S. N. M.

Edessa (Aceratodes) cornuta Burmeister

1835. Burmeister, Handb. II: 356.

1894. *Edessa bifida* Uhler, Proc. Zool. Soc. Lond. 176 (nec Say).

Sierra Rangel (Acuña and Bruner) and Taco Taco (Bruner, Acuña, and Ballou), Pinar del Rio Prov.; Camagüey, Camagüey Prov. (Acuña); Nagua, Oriente Prov. (Bruner and Ballou; Sto. Tomás, Península de Zapata, Santa Clara Prov. (Bruner and Acuña); Sta. Fe, Isle of Pines (Bruner and Bouclé)—Est. Exp. Agron. Guanajay (Palmer and Riley)—U. S. N. M.

We have followed Stal and Distant in the above determination of this species which is separable from *E. bifida* Say only by comparative differences. In the National Museum collection are deposited four specimens from the Biologia Centrali Americana series labeled *cornuta* Burm. by Distant, also many other specimens of the same thing from Mexico, Central America, and several islands in the

West Indies. As compared to *bifida*, the body is somewhat narrower posteriorly, the pronotum less convex, and viewed from the side the declivous front is less nearly vertical, the dorsal surface more profusely punctate, and the scutellum apically wider.

Edessa (Aceratodes) cubana new species
Plate XXVI, Fig. 12

Very closely related to *E. chelonia* Van Duzee. Head, pronotum, entire scutellum, outer area of the corium, and connexivum faded green; narrow lateral margins of head and pronotum and subcostal nerve yellow; inner field of the hemielytra castaneous, with irregular yellow markings, more linearly arranged at the other limits of the clavus; body beneath yellow-green, mesosternum beneath the front of the sternal process with a rather large reddish spot; antennae and legs pale, first three segments of the former minutely spotted with fuscous, terminal segment black; legs minutely spotted with fuscous.

Head one-third wider than long; lateral lobes finely and sparsely punctate; vertex somewhat elevated, faintly, transversely wrinkled. Second segment of antenna subequal to or a little shorter than third. Bucculae about four times as long as wide, evenly elevated throughout, rounded anteriorly and posteriorly. Rostrum with second segment a little longer than third and fourth together; apex confined in the anterior notch of the metasternal plate. Pronotum over two and one-half times wider than long (19:7); lateral margins narrowly impressed, straight, and forming a right angle with the humeri, which project very slightly beyond the margin of the corium; surface evenly and closely punctate and somewhat rugose on the anterior disk posteriorly to the smooth cicatrices; anterior submargin somewhat depressed in the middle. Scutellum about one-fifth longer than wide; the more depressed, flattened apical part gradually contracted to a rather narrowly rounded concolorous apex; disk coarsely and sparsely punctate; apically more closely and finely punctate. Hemielytra within the subcostal nerve closely punctate with castaneous, leaving a linear calloused yellow area on either side of the claval suture and a few scattered smooth calloused spots on the disk of corium; subcostal area much narrower than in *chelonia* Van D., closely and confluently punctate, except near base. Membrane fuliginous. Connexival segments coarsely and somewhat sparingly punctate. Canal or groove from the odoriferous orifice ending in a long tapering ridge which is plainly longer than the distance from its apex to lateral margin of pleurum. Metasternal plate with the anterior horns wider than the diameter of the rostrum, lightly divaricate, their apices rounded and reaching to the middle of the mesosternum; posterior horns short, acute. Venter yellow, mottled and spotted with green, coarsely and rugosely puntate on the sides; the broad, central, rounded ridge smooth and impunctate. Hypopygium of the male with the posterior margin deeply and widely sinuate; apex of sinus narrowly rounded; lateral lobes obtusely rounded. Length 14 mm.; humeral diameter 7.5 mm.

Type, male: Palma Mocha Mt., Sierra Maestra (alt. 1070–1350 meters), July 10–20, 1922 (C. H. Ballou and S. C. Bruner)—Est. Exp. Agron. *Paratypes, females:* 1 Cangrejeras, Havana, May 30, 1931 (S. C. Bruner)—Est. Exp. Agron.; 1 "Cuba" (C. G. Aguayo)—Univ. Nacional. Cat. No. 44049, U. S. N. M.

Very closely related to *chelonia* Van Duzee, a paratype of which from Jamaica is in the National Museum. *E. cubana* can be distinguished from *chelonia* by the more strongly impressed lateral margins of the pronotum, much narrower subcostal region, and presence of a large red spot on the mesosternum.

Edessa (Aceratodes) excoriata new species

Plate XXVI, Fig. 13

Rather closely related to *flavoflua* n. sp. Head, pronotum, entire scutellum, broad margin of the corium, connexivum, and ventral parts olive green; lateral margin of pronotum pale yellow; inner field of the hemielytra castaneous, irrorate with yellowish markings; antennae pale testaceous; first two segments plainly, third faintly spotted with fuscous; fourth segment apically embrowned; fifth fuscous, pale at base. Legs pale testaceous with apical two-thirds of femora and tibiae heavily spotted with fuscous, less evident on the two posterior pairs; body beneath more yellow green with spiracles white-rimmed; membrane fuliginous; acute apical angles of the connexival segments black.

Head short and wide, more than one-third wider than long, impunctate, transversely wrinkled, broadly rounded in front; vertex somewhat elevated; ocelli red. Antenna with second segment a little longer than third. Bucculae rather low, nearly four times as long as wide, a little higher in front, the lower edge somewhat sinuous, gradually disappearing posteriorly. Pronotum over twice as wide as long (5: 2); lateral margins straight, calloused, impressed anteriorly before middle; anterior submargin lightly impressed; obsoletely carinate down the middle; surface shallowly, sparingly punctate; anteriorly with wide rounded irregular rugae separating the punctures; cicatrices smooth, elevated, limited posteriorly by a strongly impressed line; humeral angles bluntly rounded, not projecting beyond the costal margins. Scutellum one-sixth longer than wide, flattened, somewhat impressed apical part tapering to a narrowly rounded, concolorous apex; more sparsely punctate on the elevated basal disk. Hemielytra with the clavus and mesocorium castaneous, with small scattered yellow areas; subcostal area about one-third as wide as the widest part of mesocorium; closely punctate. Connexivum broadly exposed, closely punctate; apical angles of segments slightly and acutely produced. Groove or canal from the odoriferous orifice ending in a tapering ridge, the apex of which is distant from the pleural margin for about the length of the ridge. Metasternal plate with anterior horns about as wide as diameter of rostrum, subacute, lightly divaricate. Sides of venter sparsely, coarsely punctate and rugose. Posterior margin of male hypopygium rather shallowly notched in the center. Length 11–13 mm.; humeral diameter 5.5–6.5 mm.

Type, male: Baracoa, Oriente, Aug. 21–30, 1929 (S. C. Bruner and L. Bouclé). *Paratypes, males:* 1 with same data as type; 2 Camagüey, July 15 and 23, 1923 (J. Acuña)—Est. Exp. Agron. 1 Port-au-Prince, Haiti, May, 1925 (G. N. Wolcott)—U. S. N. M. *Paratypes, females:* 3 same data as type, Est. Exp. Agron. 1 Port-au-Prince, Haiti, May, 1925 (G. N. Wolcott)—U. S. N. M. Cat. No. 44050, U. S. N. M.

Under the manuscript name *Edessa excoriata* Uhler, Gundlach records this species from Cárdenas, Matanzas Province, and Bayamo, Oriente Province. It is somewhat smaller than the preceding and similarly colored but is more nearly related to *E. flavoflua*. Besides its difference in color, the scutellum is not pale at apex, head more broadly rounded anteriorly, lateral margins less strongly impressed, humeral angles scarcely protruding, rostrum shorter, etc.

Edessa (Aceratodes) flavoflua new species
Plate XXVI, Fig. 14

Related to *excoriata* n. sp. Head, pronotum, scutellum except at apex, and connexivum pale green intermixed with yellow; narrow lateral margin and median carina of pronotum and apex of scutellum pale yellow; inner field of hemielytra testaceous; subcostal region and clavus pale yellow, coarsely punctate with fuscous.

Antennae, legs, and venter yellow testaceous. Head one-fifth wider than long; margins before sinus not parallel but gently converging to the rather narrowly rounded apex; lateral lobes strongly punctate, rugose; a smooth area at inner margin of eyes; vertex somewhat elevated, almost smooth. Second segment of antenna subequal to or a little shorter than third. Bucculae high, about twice as long as the greatest height, lower front margin rounded, broadest before middle, thence gradually diminishing posteriorly. Apex of rostrum reaching behind the anterior notch of the metasternal plate; second segment a little longer than third and fourth together. Pronotum about two and one-half times as wide as long (17: 7); lateral margin straight, with calloused yellow spots and a few fuscous punctures on extreme edge; submargins impressed and strongly, transversely rugose; anterior submargin strongly and widely depressed, coarsely punctate; a more or less evident calloused carina runs through the middle; each cicatrix occupied by a small punctate elevation; anterior disk posterior to the cicatrices strongly and transversely rugose, punctate between the rugae, giving a rough appearance to the pronotum; posterior disk sparsely and somewhat coarsely punctate; humeral angles obtusely rounded, slightly projecting beyond the costal margin. Scutellum but little longer than wide (13: 11); anterior elevated disk coarsely and sparingly punctate, the narrower apical portion more finely and closely punctate. Hemielytra with the clavus for the most part smooth, provided with a few scattered, fuscous punctures; inner field of the corium (mesocorium) most finely punctate except at apex where it is more coarsely punctate; narrow subcostal region sparsely and coarsely punctate with fuscous. Connexivum coarsely and sparsely punctate, with a pale yellow tubercle in the middle of segments 2–6; lateral apical angles of segments very slightly projecting. Membrane clear, hyaline. Groove from odoriferous orifice not terminating in a long tapering ridge; the distance from apex of groove to lateral margin of pleurum twice as long as length of groove. Anterior horns of metasternal plate rather strongly divaricate, each about the diameter of rostrum. Venter sparsely, shallowly punctate on the sides, strongly rugose; each spiracle on segments 2–6 followed by a small calloused tubercle. Posterior margin of male hypopygium lightly and broadly notched in the center; lateral lobes broad, scarcely projecting beyond apex of notch. Length 12.5–13.5 mm.; humeral diameter 7 mm.

Type, male: Viñales, Apr. 6–9, 1922 (S. C. Bruner and J. Acuña). *Paratypes, males:* 1 Soledad, Nov. 6, 1915 (P. Cardin)—Est. Exp. Agron. 1 "Cuba" (Uhler collection) labeled *Aceratodes meditabunda* Fab.—U. S. N. M. *Paratypes, females:* 2 Viñales, April 6–9, 1922 (S. C. Bruner and J. Acuña); 2 Sierra Rangel, Aug. 28, 1929 (J. Acuña and S. C. Bruner), Jan. 27–30, 1931 (J. Acuña and A. Otero) —Est. Exp. Agron. 1 "Cuba" (Uhler coll.)—U. S. N. M. Cat. No. 44051, U. S. N. M.

This is the species which both Uhler and Gundlach misidentified as *meditabunda* Fab., and this accounts for the fact that Uhler redescribed the true Fabrician species as *rugulosa*. The roughly sculptured pronotum, more pallid corium, less pointed pale apex of scutellum, and longer rostrum will distinguish this species from *meditabunda*.

Edessa (Aceratodes) chlorophyla new species

Figs. XXVI, Figs. 15 and 16

Body more elongate than in the other species here described. Color olive green, speckled or irrorate with yellow; beneath paler green intermixed with much yellow; legs and antennae testaceous, first three segments of the latter minutely speckled with fuscous; last two segments embrowned.

Head one-sixth wider than long (6: 5); lateral margin without a very distinct sinus before the eyes, almost straight, tapering to a narrowly rounded apex; surface impunctate; lateral lobes finely, obliquely wrinkled, vertex strongly elevated. Antenna with second segment subequal to third (♀). Bucculae evenly elevated throughout, the lower margins straight. Rostrum with apex reaching a little beyond apex of notch in the metasternal plate; second segment as long as third and fourth united. Pronotum well over twice as wide as long (19: 8); lateral margins straight, calloused, yellowish, not impressed or carinate; humeral angles slightly projecting, forming an obtuse angle; anterior submargin not strongly depressed; a median longitudinal carina more or less distinct, more evident anteriorly; anterior disk rugose, finely punctate between the yellowish rugae; posterior disk less distinctly rugose, with punctures closer set; transverse oval cicatrices very distinctly limited by depressed lines the smooth impunctate area within quite strongly elevated. Scutellum much longer than wide (16: 11), apical part rather narrowly contracted, with almost parallel sides; apex rounded, concolorous; disk of basal half sparsely, coarsely punctate; laterally and apically more finely and closely punctate. Hemielytra with the clavus sparsely punctated; one complete row of punctures just within the claval suture; corium closely and coarsely punctate; subcostal region narrow, about one-fourth as wide as mesocorium, more sparsely punctate. Membrane fuliginous. Connexivum green, very faintly and sparsely punctate; acuminate apical angles of segments quite prominent; apical angles of the seventh segment and all of the genital sclerites quite acutely extended posteriorly, visible from above (♀). Groove from the odoriferous orifice terminating in a long, acutely tapering ridge which is much longer than the distance between its apex and the metapleural margin. Two anterior horns of the metasternal plate long, much flattened dorso-ventrally, very

wide and lobate, three times as wide as second segment of rostrum. Venter on either side of the middle impunctate, irregularly rugose; the rugae yellowish; the broad longitudinal carina very distinctly elevated. Length 14.5 mm.; humeral diameter 7 mm.

Type, female: Taco Taco, April 1–6, 1922 (S. C. Bruner, J. Acuña, and C. H. Ballou)—Est. Exp. Agron. Cat. No. 44052, U. S. N. M.

The more elongate body, differently shaped head, and broad, flattened, anterior horns of the metasternal plate, as well as the color, will distinguish this very distinct species from the other Cuban species of *Edessa* here described.

KEY TO CUBAN SPECIES OF EDESSA

1. Apex of scutellum plainly marked with pale yellow 2
   Apex of scutellum concolorous 4
2. Pronotum distinctly rugose, carinate in middle, submargins strongly impressed ..... *flavoflua* n. sp.
   Pronotum neither rugose nor longitudinally carinate, margins not impressed 3
3. Pronotum more convex, sparsely punctate; apex of scutellum broader ..... *bifida* Say.
   Pronotum less convex, less sparingly punctate; apex of scutellum narrower ..... *cornuta* Burm.
4. Color of corium green, concolorous with pronotum and scutellum; lateral margins of head nearly straight; anterior horns of metasternal plate long and flattened; ridge terminating odoriferous orifice much longer than the distance from its apex to metapleural margin ..... *chlorophyla* n. sp.
   Color of corium in part castaneous, variegated with yellow; lateral margins of head strongly convex sinuate; anterior horns of mesosternal plate compressed 5
5. Apex of scutellum subacute; mesosternum distinctly carinate; groove from odoriferous orifice long, terminating in a very short, ill defined ridge. Much shorter than the distance from its apex to the metapleural margin; bucculae disappearing before base of head ..... *meditabunda* Fab.
   Apex of scutellum narrowly rounded; mesosternum not at all or less distinctly carinate; groove from odoriferous orifice short, terminating in a distinct, more or less elongate ridge; bucculae variable 6
6. Groove from odoriferous orifice and terminal ridge short, both together not longer than the distance from apex to the metapleural margin; venter very distinctly rugose, impunctate; first two segments of antenna and legs spotted with fuscous ..... *excoriata* n. sp.
   Groove from odoriferous orifice and terminal ridge both together longer than the distance from apex to the metapleural margin; venter distinctly punctate 7
7. Subcostal region of corium one-half as wide as mesocorium; spiracles marked with a distinct dark green spot; mesosternum yellowish ..... *chelonia* Van D.
   Subcostal region of corium narrow, not more than one-fourth as wide as mesocorium; spiracles concolorous; mesosternum with a large reddish spot ..... *cubana* n. sp.

Subfamily Asopinae

KEY TO CUBAN GENERA OF SUBFAMILY ASOPINAE

1. Frena extended to middle point of scutellum. Apical half of scutellum broad, but narrower than diameter of corium. Anterior tibia either dilated or simple. Ventral spine of abdomen long, produced nearly to intermediate coxae. At least fifth ventral segment and part of sixth on each side of the disk furnished with a patch of silky hairs in the male. Humeral angles most commonly not prominent----------*Oplomus* Spin.

   Frena distinctly extended beyond middle point of scutellum. Scutellum contracted apically behind middle, much narrower than corium. Ventral spine of abdomen variable. Humeral angles most commonly produced, often spinose or sometimes bifid at apex---------- 2

2. Second visible ventral segment of abdomen provided with a low, scarcely produced tubercle, somewhat conical anteriorly. Preapical spine of fore femora commonly obsolete. Pronotum transversely and scutellum apically calloused. Male with patches of silky hairs on segments 3–6----------*Andrallus* Bergr.

   Second visible ventral segment armed either with an evident broad, elevated, flattened process or with a distinctly produced spine. Male without ventral silky patches on the abdomen---------- 3

3. Anterior femora armed beneath with a distinct, stout, preapical spine. Bucculae strongly elevated, lower margins rounded. Second ventral segment of abdomen armed with a distinctly elevated flattened process, blunt or rounded anteriorly. Large species----------*Alcaeorrhynchus* Bergr.

   Anterior femora devoid of a preapical spine. Bucculae lightly elevated. Second visible ventral segment of abdomen armed with an anteriorly projected spine. Smaller species----------*Podisus* H. S.

Oplomus annotatus Uhler

1863. Uhler, Proc. Ent. Soc. Philad. 362.

Casa Villate, Havana (Cevera) — Est. Exp. Agron. "Cuba" (From Professor Poey in the Uhler coll.—U. S. N. M. Type No. 43581).

Rather closely related to *O. tripustulatus* Fab. and marked much as in some of the varieties of that species. It is, however, less polished, much more densely and coarsely punctate; the lateral margins of the pronotum are nearly straight and scarcely impressed. It is apparently a rare species.

Andrallus spinidens (Fabricius)

1787. Fabricius, Mant. Ins. II: 285.

Viñales, Pinar del Rio (Brother Roberto); Palmira, Santa Clara Prov. (Ballou)—Est. Exp. Agron. "Cuba" (Uhler coll.) U. S. N. M.

A widely distributed species, recorded from Madagascar, Asia Minor, India, Austro-Malayan Region, Polynesia, Mexico, and Louis-

iana. There are specimens in the National Museum collection from St. Domingo and Costa Rica. It has much the appearance of a large *Podisus* but there is no long spine on the second segment of the abdomen. The humeral angles are provided with a bifid process, the anterior spine of which is the longest; the pronotum is transversely and the scutellum longitudinally callously carinate; the legs are unarmed, with the tibiae strongly grooved. Gundlach records this as *Mutyca limbata* Uhler, a manuscript name, from Cárdenas, Matanzas Prov. and Fermina, probably in Santa Clara Province.

Alcaeorrhynchus phymatophorus (Palisot de Beauvois)

1805. Palisot de Beauvois, Ins. Afr. Amer. 112; Pl. 8, Fig. 2.

Las Animas, Sierra Rangel, Pinar del Rio Prov. (Bruner and Acuña)—Est. Exp. Agron. "Cuba" as *Canthecona grandis* Dallas (Uhler coll.)—U. S. N. M.

Distant in Biologia Centrali Americana has given some characters for differentiating this species from *grandis*. Another feature of *phymatophorus* not mentioned by Distant is the more profuse punctation of the sides of the venter.

Podisus mucronatus Uhler

1897. Uhler, Trans. Maryland Acad. Sci. I: 386.

Santiago de las Vegas, Havana Prov. (Bruner); Palmira, Santa Clara Prov. (Ballou); Omaja, Oriente Prov. (Bruner); Camagüey (Acuña); Holguin (Bruner)—Est. Exp. Agron. "Cuba" (Uhler coll.)—U. S. N. M.

Described by Uhler from Cuba and Florida. It is pale yellow, largely ferruginous above and rather closely and coarsely punctate; humeral angles armed with rather long, anteriorly directed spines; lateral margins of pronotum straight to base of spines, broadly calloused, yellow, irregularly toothed; ventral spine of abdomen rather long, extending forward to anterior margin of posterior coxae. This is represented by an unnamed specimen in the Gundlach collection numbered 159.

Podisus gundlachi (Guérin)

1857. Guérin—La Sagra, Hist. Cuba—Ins. 367; Pl. 13, Fig. 2.

Camagüey (Acuña)—Est. Exp. Agron. Cayamas (Schwarz); "Cuba" (Uhler coll.)—U. S. N. M.

A Cuban species recorded by Gundlach from Zarabanda, Fermina, and Yateras in Matanzas and Oriente Provinces. It is a little smaller than *mucronatus*. The humeral angles are greatly produced, bifid,

and turned so that the secondary subapical tooth lies directly below the main upwardly inclined tooth. A darker band runs across the pronotum between the lateral processes. The first antennal segment is extremely short, the second segment almost twice as long as third. The ventral spine of abdomen is very short.

Podisus sagitta (Fabricius)

1794. Fabricius, Ent. Syst. IV: 99.

Los Animas, Sierra Rangel and Viñales, Pinar del Río Prov. (Bruner and Acuña); Santiago de las Vegas (Hutson, Acuña, and Bruner) and Hoyo Colorado (Enamorado and Bruner), Havana Prov.; Camagüey, Camagüey Prov. (Acuña)—Est. Exp. Agron. Soledad (Myers)—M. C. Z. Cayamas (Schwarz); Upper Yara Valley and Baraguá (Scaramuzza); "Cuba" (Uhler coll.)—U. S. N. M.

Very closely related to the Mexican *fuscescens* Dallas from which it differs as follows: anterior prong of humeral bifid process not turned anteriorly; scutellum longer than wide; pronotum and hemielytra relatively wider.

Podisus acutissimus Stal

1870. Stal, Enum. Hem. I: 53.

Santiago de las Vegas (Acuña and Otero).

Three specimens show the usual variation in the character of the humeral processes and the amount of melanism on the posterior lobe of the pronotum. Professor Uhler in his article on the Hemiptera Heteroptera of Grenada records the above species from St. George as *P. gaumeri* Dist. and specimens so labeled are in the National Museum. They represent merely a pale variety of Stal's species. *Podisus cloelia* Stal, a closely related species, was listed from Cuba by Gundlach. The specimen in his cabinet so labeled does not agree with Stal's description nor with Distant's figure of the species and probably represents a form distinct from any here considered.

Podisus subferrugineus new species

Plate XXVI, Fig. 17

Stramineous, for the most part closely and finely punctate with ferruginous; antero-lateral margins of pronotum, margin of apex of scutellum, legs, and ventral parts pale yellow, the latter rather closely punctate with ferruginous; humeral spines and posterior disk of corium ferruginous-red; membrane hyaline, with a longitudinal median fuscous stripe.

Head with tylus equal to juga; the latter not contiguous at apices; lateral margins subparallel, lightly converging anteriorly; apex rounded; surface of

lateral lobes closely, vertex more sparsely punctate. Antenna ferrugino-testaceous; second segment twice as long as third, which in turn is about one-third shorter than fourth which is one-fourth longer than fifth. Rostrum reaching to just beyond posterior coxae; second segment one-third longer than third. Pronotum finely and closely punctate with ferruginous, more sparsely so across central disk; an obsolete pale longitudinal line down the middle faintly continued through the scutellum; lateral margins pale, calloused to the base of humeral spines, provided with five or six irregular obtuse serrations; humeri drawn out into very prominent acute ferruginous spines, directed outwardly and slightly upward. Pleura sparingly punctate with ferruginous. Legs pale, apices of tibiae and tarsi suffused with fuscous. Scutellum longer than wide (8: 7), depressed across the middle, closely punctate with ferruginous; apical fourth much contracted, more sparsely punctate; apex semicircularly smooth, pale yellow. Corium closely punctate at base; posterior disk more sparingly punctate with ferruginous; subcostal region coarsely punctate. Membrane hyaline, with a wide, median, longitudinal, fuscous stripe. Connexivum narrowly exposed, ferruginous-red, not fasciate with black. Venter shining, stramineous, profusely punctate with rosy-red; a pale brownish spot anteriorly on segments 3–6 midway between center and lateral margins; ventral spine short, acute, not reaching to middle of posterior coxae; apical angles of sixth abdominal segment acute, prominent. Length 12 mm.; humeral diameter 7 mm.

Type, male: Palma Mocha, Mt. Sierra Maestra, July, 1922, elevation 1070–1350 meters (Bruner and Ballou); *Paratype, female:* same data—Est. Exp. Agron. Cat. No. 44053, U. S. N. M.

This species seems to be close to *P. congrex* Stal from Mexico and Central America but the scutellum in that species is not pale at apex. In the male, particularly, the margins of the abdomen are strongly converging posteriorly.

KEY TO CUBAN SPECIES OF PODISUS

1. Humeral angles of the pronotum bifid at apices ---------- 2
   Humeral angles armed with a simple spine ---------- 3
2. Two spines of humeral process in the same horizontal plane, posterior spine much the shorter; apex of scutellum not noticeably pale ---- *sagitta* (Fab.)
   Spines of humeral process placed one above the other; apex of scutellum pale; disk of corium with a round black spot ---------- *gundlachi* (Guér.).
3. Membrane entirely fuliginous, non-vittate; humeral spines strongly turned anteriorly ---------- *mucronatus* Uhl.
   Membrane vittate with fuscous; humeral spines straight or slightly turned anteriorly ---------- 4
4. Scutellum with large smooth calloused areas in basal angles; pale yellowish or greenish species, marked with black and frequently red fascia; ventral spine of abdomen long ---------- *acutissimus* Stal.
   Scutellum obsoletely calloused at basal angles; ferruginous species with humeral spines directed outwardly; ventral spine short *subferrugineus* n. sp.

Subfamily TESSARATOMINAE

Piezosternum subulatum (Thunberg)

1783. Thunberg, Nov. Ins. Sp. II: 41, Pl. 2, Fig. 55.

A rather common species in the Neotropical regions and recorded from Cuba by Stal. Listed by Guérin from Cuba and San Domingo as *Pentatoma (Edessa) vacca* Fab. In the Gundlach collection there are three specimens taken in the Sierra Rangel, Pinar del Río Province.

This is a large species, the female measuring at least 20 mm. in length. Color greenish, often fading to yellowish. Lateral angles of prothorax produced as rounded prominences; outer apical angles of abdominal segments produced into sharp narrow points, directed backwards, more prominent on posterior segments; apex of scutellum produced into a long acute angle and provided with a prominent median carina.

APPENDIX

Guérin La Sagra Hist. Cuba–Insects 1857	Dr. Pedro Valdés Ragués Classificación Gundlach Hemípteros Cubanos, etc. 1910*	Our determination
.....	Tetyra pinguis.....	Tetyra antillarum Kirkaldy
Scutellera (Augocoris) cretacea Voet..	Augocaris 6– punctata.....	Augocoris illustris (Fabricius)
Scutellera (Augocoris) pallida Pal. B..	.....	Augocoris illustris (Fabricius)
Scutellera (Pachycoris) nitens Dallas.	Pachycoris fabrici.....	Pachycoris fabricii (Linnaeus)
Scutellera (Pachycoris) boscii Fab....	Diolchus Bosari.....	Diolcus boscii (Fabricius)
Scutellera (Pachycoris) irrorata Fab..	Diolchus irroratus.....	Diolcus irroratus (Fabricius)
.....	Diolchus variegatus.....	Diolcus variegatus Herrich–Schaeffer
Scutellera (Pachycoris) obliqua Guer.	Mesotrypa sinuosa.....	Symphylus caribbeanus Kirkaldy
.....	Sphyrocaris obliquus.....	Sphyrocoris obliquus (Germar)
Scutellera (Corimeloena) basalis Germ.	.....	Euryscytus guttiger (Stal)
.....	Corimelena minuta.....	Eucoria minuta (Uhler)
.....	Corimelena incerta.....	Euryscytus incerta (Uhler)
.....	Actas communis.....	Aethus communis Uhler
.....	Actas insularis [?].....	Aethus indentatus (Uhler)
.....	Stenocaris longulus [?].....	.....
.....	Pangarus piciatus.....	Geocnethus cubensis n. sp.
.....	Amnestris pusillus [?].....	Amnestus pusio Uhler
.....	Podops dubius	Amaurochrous dubius (Palisot–Beauvois)
Pentatoma (Brochymena) poeyi Guér.	Brochymena poeyi.....	Brochymena poeyi (Guérin)
Pentatoma (Mormidea) ypsilon Linn.	.....	Solubea insularis (Stal)
Pentatoma (Mormidea) geographica Fab.	.....	Solubea insularis (Stal)
.....	Mormidea albisignis.....	Mormidea albisignis Stal
.....	Mormidea pectiventris....	Mormidea pictiventris Stal
Pentatoma (Mormidea?) typhoeus.... Fab.	Oebalus pugnas.....	Solubea pugnax (Fabricius)
	Oebalus griseus.....	Solubea linki (Heidemann)
Pentatoma (Mormidea) pustulata.... Pal. B.	Euschistus crenator.....	Euschistus crenator (Fabricius)
.....	Euschistus bifibulus.....	Euschistus bifibulus (Palisot–Beauvois)
.....	Euschistus thorascicus....	Euschistus acuminatus Walker
Pentatoma (Prooxys) punctulata Pal. B.	Pronis punctulatus.....	Proxys punctulatus (Palisot–Beauvois)
Pentatoma (Mormidea) perditor Fab.	Thysanta perditor.....	Thyanta perditor (Fabricius)
.....	Thysanta taeniola.....	Thyanta antiguensis (Westwood)
.....	Thysanta rugulosa.....	.....
.....	Loxa Flaviclollis.....	Loxa sp.
.....	Runibra proxima.....	Runibia proxima (Dallas)
Pentatoma (Vulsirea) nigrorubra Spin.	Vulsira violacea.....	Vulsirea violacea (Fabricius)
Pentatoma (Nezara) smaragdula Fab.	Nezara viridula.....	Nezara viridula (Linnaeus)
Pentatoma (Nezara) marginata Pal... B.	No. 66 Gundlach coll..... omitted	Acrosternum marginatum (Palisot–Beauvois)
.....	Nezara marginale.....	(?) Nezara nitida (Westwood)
.....	Bonasa varians.....	Banasa subrufescens (Walker)
.....	Piezodanus Guidini.....	Piezodorus guildinii (Westwood)
.....	Modicia 6 lineata.....	Pallantia macula (Dallas)
Pentatoma (Arvelius) albopunctatus. DeG.	Arvelius albo–punctatus...	Arvelius albopunctatus (Degeer)
Pentatoma (Mecistorhinus) variegata	Pharus variegatus.....	Pharnus insulicola Kirk
Pentatoma (Aceratodes) inconspicua. H. S.	.....	Pharnus inconspicuus (Herrich–Schaeffer)
Pentatoma (Aceratodes) cornuta..... Burm.	Edessa bifida..	Edessa cornuta Burmeister
Pentatoma (Aceratodes) meditabunda Fab.	Edessa meditabunda.....	Edessa flavoflua n. sp.
.....	Edessa scoriata.....	Edessa excoriata n. sp.
.....	Ophonus annulatus.....	Oplomus annotatus Uhler
Pentatoma (Canthecona) phymatoptera	Mutyca phymatophora...	Alcaeorrhynchus phymatophorus (Palisot–Beauvois)
Pentatoma (Canthecona) gundlachii	Podysus Gundlachi.....	Podisus gundlachi (Guérin)
.....	Podysus sagitta.....	Podisus sagitta (Fabricius)
.....	Podysus declina.....	Podisus sp.
.....	Podisma pallidus.....	Modicia sexlineata Stal
Pentatoma (Edessa) vacca Fab.....	Rizostemum sublata.....	Piezosternum subulatum (Thunberg)

* Actual spelling of scientific names.

Explanation of Figures

PLATE XXV

Fig. 1. *Geocnethus reversus* n. sp.
Fig. 2. Genital segment of *Euschistus crenator* ♂
Fig. 3. Genital segment of *Euchistus bifibulus* ♂
Fig. 4. Pronotum of *Thyanta cubensis* n. sp. and *T. perditor*.
Fig. 5. Genital segment of *Thyanta cubensis* n. sp. ♂
Fig. 6. Genital segment of *Loxa planifrons* n. sp. ♂
Fig. 7. Genital segments of *Loxa planifrons* n. sp. ♀
Fig. 8. Genital segment of *Banasa punctatissima* n. sp. ♂
Fig. 9. Head, pronotum and scutellum of *Praepharnus prominulus* n. sp.

PLATE XXVI

Fig. 10. Genital segment of *Praepharnus prominulus* n. sp. ♂
Fig. 11. Genital segments of *Praepharnus prominulus* n. sp. ♀
Fig. 12. Genital segment of *Edessa cubana* n. sp. ♂
Fig. 13. Genital segment of *Edessa excoriata* n. sp. ♂
Fig. 14. Genital segment of *Edessa flavoflua* n. sp. ♂
Fig. 15. Head and pronutum of *Edessa chlorophyla* n. sp.
Fig. 16. Genital segments of *Edessa chlorophyla* n. sp. ♀
Fig. 17. *Podisus subferrugineus* n. sp.

PLATE XXIV


PINAR DEL RIO
HAVANA
MATANZAS
SANTA CLARA
CAMAGUEY
ORIENTE
ISLE OF PINES
SIERRA MAESTRA

PLATE XXV

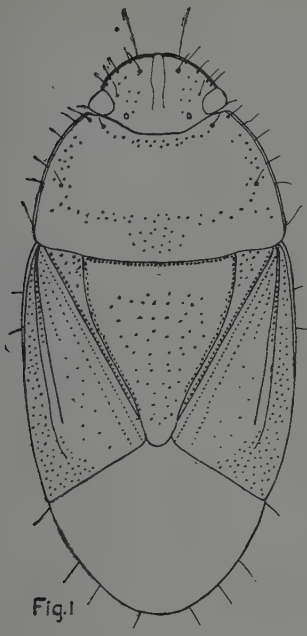


Fig. 1

Fig. 1a
Fore femur and tibia

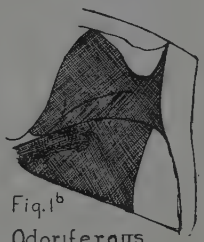


Fig. 1b
Odoriferous orifice

Fig. 2

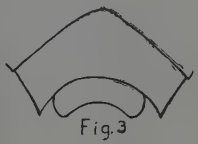
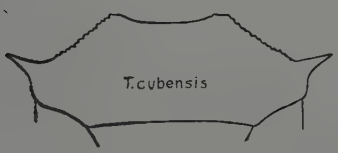


Fig. 3

Fig. 5

Fig. 8



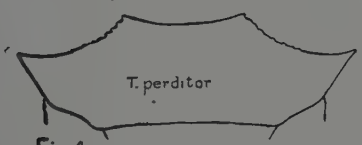


Fig. 4

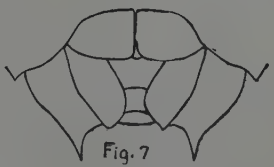


Fig. 7

Fig. 6

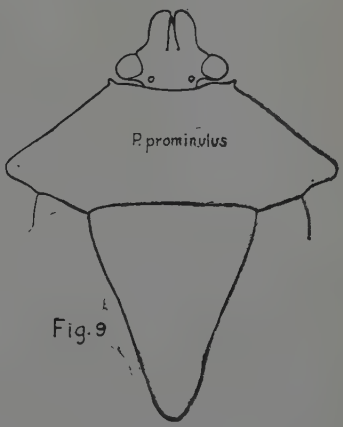


Fig. 9

PLATE XXVI

Fig. 10

Fig. 11

Fig. 12

Fig. 13

Fig. 14

Fig. 16

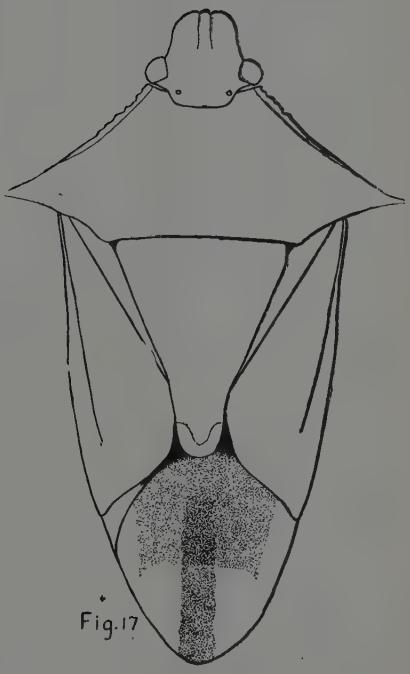


Fig. 17

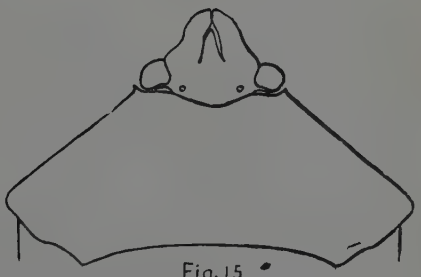


Fig. 15

INDEX TO GENERA AND SPECIES *

(Preoccupied names, synonyms, and doubtful species are in intalics.)

* NOTE: In this index are not included the species from other countries which were mentioned for comparative or other purposes in the text, and which have never been reported as occurring in Cuba.

THE DAMPING-OFF OF TOBACCO AND ITS CONTROL IN PUERTO RICO [1]

J. A. B. Nolla [2]

In recent years there has been great alarm among the tobacco growers of Puerto Rico because of the spread of a persistent malady in our tobacco seed-beds, the damping-off disease. The studies begun six years ago are outlined and discussed in this paper. The chief aim has been to develop a practical working method for the control of this dreaded malady.

Damping-off is here treated chiefly in relation to tobacco (*Nicotiana tabacum L.*). We have shown that the pathogenes responsible for damping-off of tobacco may also produce a similar disease in some garden vegetable and castor bean seedlings.

Names

The most common name for the disease in Puerto Rico is "sancocho" or "salcocho." Recently, the names "salcocho blanco" (white damping-off) and "salcocho prieto" (black damping-off), have been introduced into the long list of popular agricultural names, to distinguish between what the growers regard as two forms of the disease.

History and Range

Hesse's investigations in 1874 (16) mark the beginning of numerous researches on damping-off on many of the higher plants. Most of the literature on the subject, however, deals with the disease on suscepts other than tobacco. The disease probably occurred on tobacco as early as it did on the other suscepts. Breda de Haan (5) reported a seed-bed rot of tobacco from Sumatra and Java in 1896. Cook and Horne (9) reported damping-off from Cuba in 1905. The disease has subsequently been the subject of special studies there. Search among publications where tobacco in Puerto Rico is mentioned has shown that, apparently, the first report of the disease in that Island is by Loew (20) in 1908. To quote: "a peculiar disease, spreading from a center in ring-like progression, was observed in the

[1] A thesis presented to the Faculty of the Graduate School of Cornell University in partial fulfilment of the requirements for the degree of Doctor of Philosophy. Submitted for publication, May, 1932.

[2] Formerly Assistant Plant Pathologist, Insular Experiment Station of Puerto Rico.

tobacco seed-beds of Caguas. The circle of dead bleached seedlings increased continuously and could be checked only by removing the soil to some depth and treating the spot with diluted formaldehyde (1 spoonful to 30 gallons of water). The disease is called "sancochado" in Porto Rico."

It has been reported from various other parts of the world. In Puerto Rico it has been prevalent probably during the last three or four decades but its importance has been largely disregarded. Damping-off, in general, was briefly discussed by Johnson (19) in 1914, who placed special emphasis on the subject of the control in relation to tobacco.

This malady now occurs in both tropical and temperate zones but its severity is increased as tropical conditions are approached. In some countries soil sterilization is now a common practice and methods of culture are so advanced that the disease is rarely serious.

It is present in nearly all the tobacco soils of the true tobacco sections of Puerto Rico. One of the pathogenes, *Phytophthora Parasitica* * has not been found in the coastal section from Arecibo to Aguadilla where poorer, native types of tobacco are grown, but the other, *Pythium debaryanum,* is common. Here the temperature is relatively higher and the humidity lower than in higher elevations.

Importance

The losses from damping-off fluctuate from year to year. In certain seasons when precipitation is moderate, the disease occurs only in localized areas in the seed-beds and may be easily kept in check. On the other hand, should heavy rains be prevalent throughout a season, the magnitude of the losses will be very great. During the season of 1927, heavy rains brought about a disastrous condition. Late plantings had to be made and there were not enough seedlings for a normal planting. In many instances the seedlings were completely swept away by the disease. Reports from various sections of the island and the author's own observations showed losses from 8 per cent to as high as 90 per cent. Data obtained from the agricultural agents on about 105 acres of cloth-shaded beds and 310 acres of open beds in 1927, showed a range of infection of from 8 to 80 per cent. If a curve were to be plotted with these data, the mean would be above 50 per cent and the mode would exceed that figure. In 1928 the losses were quite severe in some sections while in 1929 the season was especially unfavorable for the disease.

* Throughout this paper the designation *P. Parasitica* stands for *Phytophthora Parasitica* Dastur, var. *nicotianae* Tucker.

Under such circumstances tobacco planting, in certain years, is quite an uncertain proposition. Even when growers plant in advance to allow a wide margin for losses from damping-off, the extent of his planting remains uncertain until the seed-bed season is nearing the end. The disease may destroy the larger part of his seedlings and then he will be at the mercy of the other planters whose seedlings may be of undesirable varieties or of poor quality. If he succeeds in buying enough seedlings for his farm he will have to pay from $1 to $1.50 or even a higher rate per thousand plants. This makes planting more expensive by increasing the cost per unit of production. Another disadvantage which may occur is the introduction of "black shank," carried into his field on poorly selected seedlings from infested beds.

Symptomatology

The morphologic symptoms of tobacco damping-off appear in various manifestations depending on the age of the plants. Very young seedlings take on a dirty green color and die. The seedlings are so violently attacked that usually the time between the first symptoms and death is very short. On larger plants, which are not overcrowded and which have not developed a slender stem, if infected at the surface of the soil, the first symptoms consist of a wilting of the leaves. This is followed by a rapid blackening of the stem all the way up to the terminal bud. The stem tissues appear to shrink. These symptoms are usually produced by *Phytophthora Parasitica*, but may also be caused by *Pythium debaryanum*.* When plants are too crowded, their stems are rather long. Here the symptoms may be evident either as small, lens-shaped or elongated lesions which do not extend far up the stem or as large lesions in the cortical tissues, originating near the soil surface and spreading up and around the stem, in a good many cases girdling it completely. These lesions are usually pale and are typical of the disease caused by *Pythium debaryanum*. Such plants will generally have the lignified tissues unaffected and when transplanted into the field will send out roots above the lesions and usually develop into normal plants. *Phytophthora Parasitica* produces very similar symptoms (see plates XXVII, XXVIII and XXIX.) Occasionally lens-shaped lesions will be formed on the stems and adventitious roots develop. When transplanted into the field during a rainy period such plants rapidly succumb to the attacks of the invading fungus. The organism in the small lesion commences activity on reaching the new environment. Such a con-

* Since these two pathogenes produce damping-off effects almost identical on tobacco they are here discussed as producing one disease.

dition had been thought to be due to a cause different from that of the damping-off but it has been found that *P. Parasitica* is the responsible agent. Roots of young seedlings are not usually affected as the pathogenes seem to spread more readily over the surface of the soil and infect the stems at soil level. However, roots of the larger seedlings may furnish the point of invasion. This is especially true in the case of *Phytophthora Parasitica.*

The leaves are also a common point of entrance for the pathogenes. The symptoms here consist of circular to irregular light-brown spots with light centers. The plesionecrotic zone between the unaffected and necrotic tissues is pale green. The spots rapidly increase in size and involve the entire leaf blade, and in later stages extend to the stem where blackening and death of the tissues occur and ultimately the death of the plant.

The histologic symptoms consist, in the first place, of hydrosis of the tissues, especially when infection occurs in the leaves. The cells of the invaded tissues are soon killed by toxins or related products secreted by the penetrating hyphae, and the cell walls and cell contents are blackened presumably as a result of the reactions with the fungous secretions. Collapse of the cells is followed by the dissolution of the primary walls of the mesophyll cells of the leaf or of the cortex of the root, as the case may be. Withering of the affected individuals soon follows. The vascular tissues, especially in infections by *Phytophthora Parasitica* are also stained and killed. This results in the wilting of the above-ground parts.

Signs

Sporangia are produced abundantly in the soil by *Phytophthora Parasitica* and to a lesser extent by *Pythium debaryanum.* However, *Pythium debaryanum* forms oospores in the soil and in the tissues of the affected organs. Oospores of *Phytophthora Parasitica* have not been found in the tissues of diseased seedlings. Chlamydospores are formed in the infected parts when either of the two pathogenes is present.

Etiology

The pathogene *Pythium debaryanum* was discovered and described by Hesse in 1874. It was named in honor of the famous German mycologist, Anton de Bary. There is now a long list of publications on this fungus, in which it is recorded on a large number of suscepts.

The other pathogene, *Phytophthora Parasitica* var. *nicotianae* was first described as *P. nicotianae* by Breda de Haan in 1896 (5). This

fungus was first associated by its discoverer, with the cause of the "lanas" disease; and known in America as the black-shank. A serious seed-bed trouble was found to be caused by the same fungus in the Deli district of Sumatra and at Buitenzorg in Java.

Tisdale (27) first reported the black-shank organism from America in 1922 as causing a typical damping-off in young tobacco plants. Later, in 1923, he (28) gave *Phytophthora nicotianae* Breda de Haan as the cause of black-shank.

In Puerto Rico damping-off of tobacco is due to *Pythium debaryanum* and *Phytophthora Parasitica* var. *nicotianae*. Rhizoctonia has not been found in the tobacco seed-beds, but an examination of some plants received from the Cayey region in January, 1930, showed the presence of this fungus, and it might well be that the pathogene is spreading in that section. *Sclerotium Rolfsii* was isolated from yellowed seedlings but it does not seem to be able to cause much damage.

That the Phytophthora on tobacco in Puerto Rico is *P. nicotianae* was established in a previous paper by the author (23). The cultures used in this investigation were the same isolates studied in connection with the black-shank disease. Ashby (1) in 1928 proposed the name *Phytophthora Parasitica* Dastur for a combination of species among which is *P. nicotianae*. Obviously he ignored any suscept relationship. Tucker (29) who has been unable to separate *nicotianae* from *Parasitica* on a morphological basis, regarded the difference in pathogenicity between the two as not of specific significance and, therefore, designated the fungus *P. Parasitica* Dastur, var. *nicotianae* Tucker.

The omnivorous *Pythium* in Puerto Rico has been isolated from many suscepts. The isolates when compared with known cultures of *Pythium debaryanum* have shown only slight or no morphological differences.

Pathogenicity

The pathogenicity of our isolates of *Pythium debaryanum* and *Phytophthora Parasitica* was established by a series of experiments.

The following list of isolates used is given with their sources;

P 1. *Phytophthora Parasitica,* from a tobacco seed-bed in Cayey;

P 2. *Pythium debaryanum,* from a tobacco seed-bed in Caguas;

P 3. *Phytophthora Parasitica,* from a tobacco seed-bed in Cayey;

P 4 to P 14. *Phytophthora Parasitica,* tobacco black-shank Caguas;

P 16. *P. debaryanum,* tobacco plant with black-shank lesions, Cayey;

P 17. *P. Parasitica,* disease of young transplants; Cayey;

P 18. *Phytophthora* sp., tomato damping-off or bending-over, Río Piedras;

P 19. *Phytophthora* sp., eggplant fruit rot;

P 20. *Pythium debaryanum,* cucumber damping-off, Río Piedras;

P 216. *Phytophthora Parasitica,* obtained from Trucker who obtained it from Tisdale—the Florida black-shank fungus;

P 217. *Phytophthora* sp., obtained from Tucker but source unknown.

Not all of these isolates were used in all experiments because they were gradually accumulated during the course of the investigations.

The flats in which most of the pathogenicity experiments were conducted were prepared as follows: A wooden box 2 ft. × 2 ft. was filled with good compost. A frame about 2 ft. high was built around each box. Cell-o-glass was then fastened tightly to this frame, the lower edge extending about 2 in. below the upper edge of the sides of the box. This insured the contents against possible infestation from external sources. Frame-covers were also provided in order to prevent rain water from falling into the box.

As soon as the flats were filled with the soil compost, they were sterilized with a 1–50 formaldehyde solution, at the rate of 1 gal. per sq. ft. or 4 gal. to each flat. After the soil was well soaked with the solution it was covered with burlap for 48 hours.

A week after disinfestation, the soil was infested with cultures of the isolates to be tested. At the end of 7 days after infestation of the soil seed was sowed of the types "Borinquen" or Connecticut Round Tip (very susceptible to black-shank) and a native type called "País" (resistant to black-shank). The beds were heavily watered with boiled water every morning, until the experiment was completed.

Expt. 1: Twenty-four flats were used, three were left uninfested to be used as checks while the remaining 21 were infested on Dec. 22, 1926 as follows: A set of 3 flats with P 1, P 2, P 3, P 4, P 10, P 13, and P 14. These flats were sown on Dec. 29 as follows: 2 flats in each set with "Borinquen" seed the remaining flat with "País" seed. The check was similarly seeded.

The results observed at intervals of 2 days until Jan. 21, 1927 were as follows:

(*a*) There was an even germination on all the 24 beds.

(*b*) P 1 (*Phytophthora Parasitica*) produced a virulent infection on Jan. 10 and in 3 to 4 days had destroyed all the seedlings in the three flats alike.

(*c*) P 2 (*Pythium debaryanum*) showed infection on Jan. 10, and by Jan. 18th all the seedling in the three flats had been killed.

(*d*) P 3. The first symptoms were observed on Jan. 10. Later on Jan. 13 there were only a few plants standing.

(*e*) P 4 and P 10 showed the symptoms later than in the preceding three cases but by Jan. 21 nearly all the plants had been destroyed.

(*f*) P 13 and P 14 showed infection on Jan. 18 and by Jan. 21 there were only a few seedlings unaffected.

(*g*) No damping-off developed in the checks, the plantlets attaining a normal development.

There are two conclusions to be drawn from this experiment, namely, that both *Pythium debaryanum* and *Phytophthora Parasitica* cause severe damping-off of tobacco seedlings and that there is no difference in the resistance or susceptibility of the two varieties of tobacco used.

A second experiment was conducted in which infestation was made 16 days after germination and when seedlings were making a vigorous growth. Ten-day-old mass cultures of P 216, P 217, P 16, P 17, P 18, and P 20 on cotton-seed meal agar were employed.* The cultures were broken up into small fragments, poured into tin pans and water was added so as to obtain a good dilution. This was then sprinkled over the seedlings and washed into the soil with water from sprinkling cans.

A week after infestation symptoms of the disease had appeared in all of the infested flats except those with P 18 and P 217. Spots on leaves appeared only in the flats infested with P 17 and P 216.

From these results it may be concluded that, (1) the Florida black-shank pathogene *P. Parasitica* (P 216) causes typical damping-off; (2) the *Phytophthora* sp. (P 217) is non-pathogenic to tobacco seedlings; (3) two *Pythium* strains from tobacco (P 16) and cucumber (P 20) produce typical damping-off; *P. Parasitica* (P 17) from transplant tobacco causes typical damping-off, and (5) a *Phytophthora* sp. which causes bending-off in tomatoes does not cause the disease on tobacco.

* Prepared by adding to 40 grams of cotton-seed meal, 4 grams of agar-agar and water enough to make the volume to 200 cc. in an Erlenmeyer flask, then heating in the autoclave at the usual temperature for sterilization.

Life History

An account of the life history of *Phytophthora Parasitica* has been given in another paper (23). In the account of the life history for *Pythium debaryanum* given below, it will be seen that it is similar to that of the former. The primary cycles are initiated on the seedlings by inoculum from the soil or from bits of diseased plants carried into a pathogene free seed-bed by agents of dissemination. The inoculum consists of mycelium from infested debris and of oospores, chlamydospores, conidia, and zoospores. Inoculation is effected by the growth of the inoculum to the susceptible part or by its transportation to the suscepts by agents of various kinds. Surface water currents, laborers, animals, and probably burrowing insects as well as other agents serve to disseminate it.

With favorable conditions of temperature and moisture, the oospores, and probably the chlamydospores may be assumed to germinate. Laboratory attempts to germinate the oospores and chlamydospores have been unsuccessful, an experience which confirms that of other writers. The germ tubes from the oospores must come into contact with the suscepts, or, failing to do so, they develop into a mycelium in the soil.

The mycelium under adequate temperature and humidity conditions assumes a very active role. Zoosporangia and conidia are developed at the end of special hyphae. The zoosporangia germinate in the water on the suscepts' surfaces or in pools, giving rise to zoospores. These and the conidia germinate by sending out a germ tube. The term conidium is used here in the sense of many authors for the sporangia which do not germinate by zoospores but by a germ tube. There seem to be no grounds for regarding these as distinct structures, both are, undoubtedly, genetically alike and the manner of germination may be, after all, influenced by external factors not yet well understood.

Germ tubes and the hyphal tips of the mycelium coming in contact with the susceptible surfaces penetrate the cell-walls of the tissues. Hawkins and Harvey (15) present evidence to show that the hyphae of *Pythium debaryanum* penetrate the cell-walls of the potato tuber by means of mechanical pressure. The germ tubes or hyphae may enter the plant through the stomata. Zoospores of *P. Parasitica* occasionally brought into contact with the leaf surface at the margin of the blade by splashing rain drops or other means, send their germ tubes into the tissues, in this manner giving rise to the characteristic spots. We have been unable to get infection of leaves with zoospores of *Pythium debaryanum*.

Once the hyphae or germ tubes find themselves inside the suscept tissues they begin to invade these. The mycelium becomes much branched and advances in all directions. The hyphal branches penetrate the cell-walls or may penetrate in an intercellular manner. The hyphae of *Pythium debaryanum* become constricted at the place where they pass through a cell-wall. However, this phenomenon has not been observed in *Phytophthora Parasitica*. It has been generally accepted that *Pythium debaryanum* secretes a substance which kills the cells of the suscepts in which it occurs.

During the course of the development of the pathogene on the tender stems and leaves of the tobacco seedlings zoosporangia and conidia are produced. These are more abundantly produced by *Phytophthora Parasitica* but on the other hand, *Pythium debaryanum* produces an abundance of oospores in the tissues and in the surrounding soil; while the former produces only a few. Chlamydospores are produced by both pathogenes. The sporangia germinate readily under favorable environmental conditions and their zoospores together with the germinating conidia (probably also chlamydospores and oospores) furnish the inoculum for the secondary cycles. The primary cycles end with the death of the seedlings. Only in a few cases, when affected plantlets have developed vigorously, does recovery from the disease occur, and then only when the pathogene involved is *Pythium debaryanum*. Seedlings at any age or period of development, when infected by *Phytophthora Parasitica* die. After the destruction of the plants in a bed or part of them, the land is usually left idle. The pathogenes now enter into a new phase of their life history. They are able to hibernate in the debris of the dead seedlings or in organic matter of any kind. Here they spend a saprophytic life awaiting the reappearance of any one of their suscepts.

Epiphytology

Environmental conditions seem to affect both pathogenes similarly. The amount of moisture in the soil seems to be the most important factor determining the spread and severity of these pathogenes. Under conditions of extreme humidity the disease plays havoc with seedlings. It is natural to expect this with pathogenes which have such life habits and characteristics. In sections where rainfall is slight there is seldom any fear of damping-off. Temperature variation is not an important factor in Puerto Rico since favorable temperatures prevail through the year. In our experiments, conducted at all seasons, temperature fluctuations have not appeared to influ-

ence the occurrence and spread of damping-off very much. Seed-beds shaded with cloth are usually more liable to suffer severely. In those where no shade has been used, the disease has been checked with less difficulty. That some beds of seedlings have been saved by removing the cloth and allowing the sun rays to penetrate directly to the surface, indicates that the reduction of the moisture on the surface of the soil and on the plants, removes the chances of spread and development. The elevation at which the seed-bed is located in Puerto Rico seems to have little influence on damping-off.

Damping-off is usually severe in beds which have been heavily fertilized with nitrogenous fertilizers. This is true of soils manured with the more soluble salts such as nitrate of soda, and beds periodically watered with solutions of the salt. But organic manures seem to afford the best conditions for its development. Fresh barnyard manure furnishes a good medium for the pathogenes already existing in the soil. Barnyard manure in Puerto Rico is worse than nothing in the preparation of seed-beds and its use should be discouraged. Fortunately, the average grower has learned this from experience and there is little likelihood of its being used to any great extent. However, when seed-beds are properly disinfested and well managed there will be little danger from organic matures.

Thick sowings are a constant danger in Puerto Rico. In spite of the fact that during the last two decades the growers have been advised by private parties or by government agents to make as light sowings as possible, the present day growers still insist in getting a very large number of plants per unit area. The experiences of the season of 1927 show this very plainly. We found cases of growers who had been managing tobacco seed-beds for the last ten or twelve years for a certain tobacco company, and had then used only about 2 pounds of seed to the acre. When they started in work of their own they made sowings at the rate of 4 pounds to the acre. The result was an overcrowding of seedlings in the seed-beds. With the coming of the rainy season, damping-off occurred and the destruction was almost complete. Experience in Puerto Rico shows that not more than 1.5 to 2 pounds of seed should be sown to an acre.

Control

Eradication

General Considerations and Miscellaneous Practices

The control of tobacco damping-off is at present one of the problems which the tobacco growers have to face. Practical treatment

for beds before or after the germination of the seed will be welcomed by the growers of tobacco in Puerto Rico.

The first known and most general treatment of the land for the control of plant diseases ever recorded for Puerto Rico is the destruction of the causal organism by fire. The first records of the use of this means for the cleaning or sanitation of soils intended for seed-beds are lost in the rather obscure history of Puerto Rican agriculture. The pioneer tobacco growers in the island did not know that plants would die from disease; when tobacco culture was first attempted their virgin lands probably were free from infestation. In some sections of the country the clearing of the land was followed by burning of the trash, shrubs, and trees. In other cases (especially recent ones, which the writer has seen), the beds were prepared in places where the plant "maya" (*Bromelia Pinguin*) had been growing for years. This large terrestrial bromeliaceous plant grows thickly in waste places and along fences and these seemed favorite places for tobacco beds. When set on fire these plants burn slowly since their leaves are more or less juicy. This slow burning develops an intense heat, which is maintained in the soil for a relatively long time. This may be an explanation for the small amount of damage produced by the so-called rot or damping-off in seed-beds prepared in such sites. Without knowing it these growers with their rude methods were preventing a serious trouble. Later as seed-beds had to be increased in extent the patches of "maya"-covered land had to be abandoned for other waste lands. In other sections this system was unknown, but instead grass was burned over the soil. Gradually with the clearing of land the amount of material to be burned on the soils intended for seed-beds decreased and the seed-beds received no treatment whatsoever. The disease called here "pudrición" (rot) or "salcocho" (damping-off) began to increase year after year until it is now widespread over the entire island. The method of firing as used by the first growers was an effective one under the conditions of slight infestation then prevailing. Its effectiveness decreased when beds were less frequently exposed to the action of the heat and when they received contamination from adjoining fields through surface drainage.

A second eradicatory measure, but a poor one, used by our growers has been the removal of the diseased seedlings from the fields as soon as the disease appears. This practice is effective in the control of some diseases and, most certainly, in those cases where the disease occurs in isolated individuals; but in the case of tobacco damping-off, especially in Puerto Rico, it is very dangerous. The

type of labor employed in this kind of work does not commend its use. A laborer who removes diseased seedlings will only serve to spread the inoculum over healthy beds. In the majority of instances the rotting plants have been scooped out and thrown into the ditches where they await the coming rains to wash them down to other ditches and into other beds. After seedlings have been removed it is the practice to dust the bare spots with slaked lime. This lime does not kill the fungus and observations show that even indirectly it will not check the spreak of the pathogenes. It is an unfortunate thing that methods like this should even be mentioned in the literature as effective. Bunker (4) says "The practice of scraping off the infected soil and applying lime is good." However, immediately after, he describes a method which is more satisfactory and which shows there was no need of approving the former. This latter method consists in spraying the infested areas well into the surrounding heathy plants with a 1–25 formaldehyde solution. After soaking with this solution the diseased plants may be removed from the beds. We are of the opinion that this is a good measure to follow. We have used a slightly lower concentration, a 1–30 solution, with equally good results. Once the infested spots have been thus drenched, the removal of the infected plants seems to us rather unnecessary. There is little likelihood that these will serve as sources of inocula. Recently we have succeeded in obtaining excellent results with a new copper preparation—a copper fluosilicate dust. This material has a very high content of copper in the soluble form. When applied to infested spots in tobacco beds it soon burns the foliage and stems. At the rate of about 8 grams to the square foot of surface it gives as good results as the 1–25 or 1–30 formaldehyde solution. It has the advantage over the latter in not having that penetrating, undesirable odor. Further, its action is longer continued than that of formaldehyde. It is a good plan to sprinkle the beds with water after dusting with copper fluosilicate dust. A 1–200 Uspulun solution at the rate of 1 gallon to the square foot of surface has also given satisfactory results but none of the treatments are as simple and effective as dusting with copper fluosilicate.[1]

Of historical interest is the case reported by Loew (20) of a certain Mr. DuBois who had introduced a new system for preventing the disease, by transplanting the young seedlings into a second seedbed before they were set in the field. It is of further interest to note that the writer observed exactly the same system employed by

[1] After this paper had been prepared the writer was informed that this compound will not be prepared any longer.

the farmers of Colombia, South America, in 1929. This is a rather primitive method which is inapplicable and uneconomical on a large scale.

Eradication of pathogenes by soil treatments before sowing the seed

Steaming of the soil

It is highly improbable that soil disinfestation by means of steam can be adapted to Puerto Rican conditions. Its successful use in other countries makes it a very satisfactory treatment under certain conditions. Atkinson (2) in 1895 suggested the use of steam for the control of damping-off in plant beds in severe cases. Gilbert (14) finds steam sterilization to be the best means of preventing tobacco root-rot. Clinton (7) comparing steam sterilization with the formalin drench in the control of tobacco root-rot found the steam treatment of beds as effective, with the additional advantage of being more efficient in killing weed seeds. Johnson in 1914 (19) in studies on the control of damping-off in plant beds with special reference to tobacco damping-off (*Pythium debaryanum* or *Rhizoctonia*) compared steam disinfestation with other means of treating beds, and concluded that the former was the most satisfactory method of preventing the disease.

In our opinion Puerto Rican growers will not resort to this means of eradication of the damping-off pathogenes. The economic conditions in the tobacco regions are more and more pressing every year and expense is the most important item. The cost of machinery and equipment needed in the treatment of plant beds by the steaming method is so high that it is prohibitive even for the more wealthy growers. It might be possible to introduce it by cooperative undertaking; but it is improbable that this will be accomplished.

The formaldehyde drench

History

It is generally admitted that the treatment of soils with a formaldehyde solution is an effective method in the control of fungus seedbed troubles. This disinfestant was first employed in eradicating soil fungi by Selby (24), in 1889 and 1900. He applied it to soils infested with the onion smut fungus *Urocystis cepulae* Frost. Later in 1906, this same investigator (25) recommended the treatment for the control of Rhizoctonia bed-rot and Thielavia root-rot on tobacco seedlings. It consisted of applications of a formaldehyde solution

(2½ pounds of 40 per cent fomaldehyde in 50 gallons of water) at the rate of 1 gallon per square foot of bed surface. The concentration is much weaker than that now recommended. This appears to have been the first attempt to control tobacco seed-bed troubles by the use of formaldehyde. In 1907 Clinton (l. c.) obtained good results with formaldehyde in the treatment of plots and crocks for the control of the Thielavia root-rot of tobacco. He used a 1–100 solution and applied it at the rate of 1 gallon to the square foot. Clinton says, "We believe that the formalin treatment is a very efficient and convenient method of protecting tobacco beds against root-rot and possibly the damping-off trouble." Yet, Selby (l. c.) had found the damping-off fungus (*Pythium*) occurring in treated seed-beds.

In 1909 Gilbert (l. c.) reported the results of beds treated with 1–200 and 1–300 solutions at the rate of ¾ gallon per square foot for the control of tobacco root-rot as only a little better than the untreated. In the same publication he states that a 1–100 solution might be used advantageously. In 1914 Johnson (l. c.) reported effective control of damping-off (*Pythium debaryanum* or *Rhizoctonia*) of tobacco with 1–50 formaldehyde solution applied at the rate of 2 quarts per square foot of surface. This is the concentration and rate recommended today.

Many other papers have appeared recommending formaldehyde for the eradication of damping-off. Among these there is one by Chapman (6) for tobacco damping-off.

Although the formaldehyde disinfestation of tobacco seed-bed soils in Puerto Rico seems prohibitive on account of the cost, experiments have been made to determine the efficiency of the treatment as practiced in other countries in the control of damping-off.

Experiments in Puerto Rico

(1) A set of trials was started in December 1926 as follows: twelve flats 2 ft. × 2 ft. and one foot deep were filled with a soil mixture containing about 50 per cent barnyard manure. Ten of these flats were drenched with a 1–50 formaldehyde solution, at the rate of two gallons per flat or ½ gallon per square foot of soil surface. Two flats remained untreated and kept about 10 yards away from the treated flats. The treated flats were covered with burlap for about 2 days. Tobacco seed was sown in the twelve flats a week after treatment. The notes taken a month after germination were as

follows: complete damping-off in the two untreated flats, some damping-off in four of the treated flats; six of the treated flats were healthy. (2) This experiment was repeated in flats where the chances of contamination after treatment were obviated. They were raised about 2 feet from the ground on a wooden platform. The flats were surrounded by frames of cell-o-glass (impermeable screen) about two feet high and nailed tightly to the sides of the boxes. Another frame was employed as a cover. The soil used was the same as for the first experiment. Six such flats were treated with the 1–50 formaldehyde solution, one was kept as a check. Damping-off occurred virulently in the check flat and in two of the treated flats. (3) In a third case data was obtained on 10 flats totalling about 90 square feet of surface which had been treated with a 1–50 formaldehyde solution at the rate of 1 gallon per square foot and planted with "Virginia Blanco" tobacco seed. Damping-off appeared in the flats about two weeks after germination of the seed. Reinfestation of the soil may have occurred, although this is not very probable. (4) In a fourth experiment 8 flats (5 ft. $\times$ 3 ft.) were disinfested as above in October 1927. The flats were covered with cell-o-glass movable frames soon after disinfestation. The flats were watered liberally, twice a day. Final observations on November 26, 1928 showed no damping-off in any of the flats. (5) A fifth experiment was started in the latter part of November and completed in December of 1927, using cultures of *Phytophthora Parasitica* and *Pythium debaryanum* for infesting the soil which contained in itself a high percentage of barnyard manure. The cultures were about one week old, vigorously growing in oatmeal agar. Each flat received 500 cc. of the culture. Six flats 5 ft. $\times$ 3 ft., were used, two for each one of the pathogenes and the remaining two as uninfested checks. The four infested flats and one of the checks received an application of 1–50 formaldehyde solution at the rate of one gallon per square foot of soil surface. This was made two weeks after infesting the soil. It was found in this trial that the *Pythium debaryanum* flats and the treated check flats were healthy at the end of the experiment; the *Phytophthora Parasitica* flats developed small areas of the disease; while the untreated checks developed damping-off which soon killed all the seedlings. (6) In a sixth case observations were made and notes taken on a one-acre tobacco plant bed disinfested by the Porto Rican Leaf Tobacco Co. with a 1–50 formaldehyde solution at the usual rate. The treatment was made in

December of 1927 soon after clearing part of a field which had been growing a tobacco seed-bed sown early in the fall. When the last notes were taken on January 20, 1928. damping-off had appeared in some of the treated beds. This occurred after a rainy period. Generally the treatment was effective. It may be noted that the application was not as thorough as is recommended, when one considers that most of the ditch space was left untreated. Then also the spread from one ditch to the other by the feet and shoes of the laborers who attend to the watering and weeding is an important factor not to be overlooked. The weather was, however, especially unfavorable for the development of the disease; rains were light and there was maximum sunlight. Therefore, the rather unsuccessful results in this trial must not be attributed to the treatment alone but the other factors influencing the severity of the disease must be considered.

Summarizing our own experiments and experiences with the formaldehyde treatment, it is concluded that: (1) a 1–50 concentration applied at the rate of ½ gallon to the square foot of surface is not an absolute disinfestant for soils infested with *Pythium debaryanum* or *Phytophthora Parasitica,* at least under Porto Rican conditions. (2) Formaldehyde at a 1–50 dilution and applied at the rate of 1 gallon per square foot is probably ineffective in eradicating the pathogenes. (3) *Phytophthora Parasitica* appears to be slightly less susceptible to the sterilizing action of formaldehyde than *Pythium debaryanum.* (4) The results of treatments are always shifted one way or the other by environmental conditions. (5) The location of plant beds in the island is such that reinfestation is very apt to occur at the time of the heavy rains. Infested soil may be washed down the hills into the beds. Under such circumstances the disease will develop and spread rapidly in the formaldehyde-treated soil. (6) The method is too expensive and, therefore, inapplicable in Puerto Rico.

Other Chemical Treatments

History

On tobacco beds Johnson (l. c.) reported benefit from the application of 0.4 per cent and 0.5 per cent sulphuric acid by weight. This amount he held to be as high as could be used in order to permit the germination of the seed. It appears that the little work done with sulfuric acid on tobacco damping-off has been unsuccessful.

In 1907 Horne (17) recommended the use of Bordeaux mixture for combating the damping-off of tobacco seedlings. Later in 1908

he (18) gave the treatment and preparation of the mixture in more detail. He used 6 lbs. of copper sulphate and 15 lbs. of slaked lime paste in 50 gallons of water, applying 1 gallon of the mixture to every 10 square feet of soil surface. This seems to be the first attempt at a practical solution of the problem of tobacco seed-bed troubles with chemicals other than formaldehyde.

In 1914 Johnson (l. c.), in experiments on the control of tobacco and garden cress (*Lepidium sativum*) damping-off, found inhibitory action on germination of seedlings with lime-sulfur, potassium sulphide, copper sulphate and mercuric chloride treatments. For this reason he thought there was little value in those disinfestants as soil fungicides. In the same experiments he obtained a decided decrease of the disease in soil treatments with Bordeaux mixture.

In 1919 d'Angremond (10) stated that tobacco could be protected in the nurseries with Bordeaux spraying and, later in that year, he (11) gave results of treatments of dessa manure or native compost for the destruction of *Phytophthora Parasitica*. He used benzine at the rate of 2.5 liters per cubic meter with no favorable effects; but his application of 510 grams of carbon bisulphide to the cubic meter was quite successful. This same worker (12) reported in 1920 the treatment of manure with copper sulphate as inadequate but carbon bisulphide was again successful. The latter treatment is, however, not practicable.

In 1925, Cook (8) recommended the use of 5–5–50 Bordeaux mixture, applied every 3 or 4 days for the control of tobacco damping-off. No information on the quantity of spray per unit area was given.

Major (22) found mercury compounds were injurious to tobacco plants in seed-beds when he used it for the control of the Thielavia root-rot.

In 1926, Bunker (3 and 4) advocated the Bordeaux mixture treatment but applied every 2 or 3 days. He did not give the amounts of the mixture to apply.

Thomas (26) controlled damping-off of tomatoes caused by *Phytophthora* sp. with copper carbonate, mercuric chloride and Uspulun. Mercury compounds were effective against Rhizoctonia in cabbage and tomatoes; copper carbonate and two forms of colloidal copper were ineffective in controlling this disease.

Lucca (21) has more recently reported control of tobacco damping-off with treatments of a 5–8–50 Bordeaux mixture. He says spray-

ings were made every 3 or 4 days but fails to give the amount of the spray per unit area.

More recently Doran (13) has found that he can protect tobacco against black root-rot and damping-off with an application of 1 to 1.2 per cent acetic acid solution at the rate of one-half gallon per square foot.

It is evident from the foregoing review of most of the investigations and reports on treatments for tobacco damping-off that formaldehyde and acetic acid are, in a general sense, effective treatments against damping-off of tobacco, but the objection raised against them is their inefficiency in protecting seed-bed soil from reinfestations that usually follow. To be applicable, cost excepted, to conditions in our country, a system, of more or less permanent seed-beds should be installed whereby the soil, once disinfested, could be protected from reinfestations. As previously stated, the main disadvantage would be in the cost of the treatments. The Puerto Rican growers are in need of cheaper methods of control. The use of mercury compounds has been discouraging on tobacco seedlings, injury having been reported. Bordeaux mixture has been used to advantage in Cuba and in Puerto Rico, but the details of the treatment have not been worked out on the basis of its usefulness, practicability and economy. Recently some new copper dusts have been tried by Thomas (l. c.) against the damping-off of tomatoes and other vegetables with such beneficial effects that it appeared to us that they might be promising in the control of our tobacco seed-bed troubles. These have the very desirable quality of being applied in the dust form, doing away with the inconveniences of spraying. This virtue is to be courted in any disinfesting treatment for soils.

A number of copper and mercury compounds have been used in our experiments with formaldehyde as a check. Mercuric chloride and two organic mercury compounds whose commercial use is probably prohibitive, have been used for the sake of comparison. Acetic acid has also been employed in the experiments.

In the following experiments, unless otherwise stated, the flats used were about ten inches deep. They all were protected from unnecessary insolation by cheesecloth shade. Ample drainage was afforded by means of ditches between the beds and flats. In every case much care was exercised to prevent the spread of the pathogenes from one bed or flat to the other. The seed was mixed with cotton-seed meal to facilitate even distribution.

Experiments with Corona Copper Carbonate

The copper carbonate dust employed in the following experiments contains about 20 per cent metallic copper.

Experiments in flats and experimental beds

In all experiments, unless otherwise specified, the soil was a compost made of six parts of heavy loam, one of well rotted barnyard manure and one part of sand.

Rate of application. Five sets of four flats each, 5 ft. × 6 ft. × 1 ft. were infested with isolates P 1, P 2, P 3, and P 10 and P 13, while a fifth set of four flats was left uninfested to serve as checks. An application of ½ gram, 1 gram, 2 grams, and 4 grams per square foot, respectively, of the chemical was made in each set of infested flats. It was dusted over the surface uniformly with a fine-mesh sieve and then well raked into the upper inch of soil. The soil was kept moist in all the flats. The twenty-five flats were sown thickly with Connecticut Round Tip seed two weeks after treatment. All the flats were kept well watered during the course of the experiment. Observations were made at short intervals.

Two weeks after germination, it was found that damping-off was quite severe in nearly all the flats. A second application was made to all flats (except the checks) at the same rate as before.

The dust from the second application was well washed into the soil by sprinkling the plants with water. The results are given in Table 1.

At the end of the experiment it was evident that: (*a*) all seedlings in the checks were affected; (*b*) the majority of plants died in the flats infested with P 1 and P 3 and treated with 2 applications of ½ gram, 1 gram, and 2 grams per square foot of surface; (*c*) the majority of the plants died in flats infested with P 2 and P 10 and P 13 when applications of ½ gram and 1 gram were made; (*d*) a fair control of the disease in flats with P 1 and P 3 when 4-gram applications were made and in those with P 2 and P 10 and P 13 when either 2- or 4-gram applications were made.

In another experiment with Corona copper carbonate, the dust was applied to the beds (20 ft. × 3 ft.) at the rate of four grams to the square foot of surface. The first application was made one week before the seed was sown and a second application followed two weeks after germination of the seed. In this experiment three beds were infested with a mixture of cultures of *P. debaryanum* and *P. Parasitica;* and of these beds one was left as a check. At the time when seedlings were of transplanting age no disease was ob-

served in the treated beds, while the seedlings in the check bed had been mostly destroyed. (See plates XXX, XXXI and XXXII.

TABLE 1

EFFECT OF CORONA COPPER CARBONATE. ONE APPLICATION A WEEK BEFORE SOWING OF SEED, A SECOND 2 WEEKS AFTER GERMINATION

Application per sq. ft.	Results—Severity of Disease							
	P–1		P–2		P–3		P–10 & P–13	
	March 21	April 11	March 21	April 11	March 21	April 11	March 21	April 11
½ gram	2 diseased areas	90%*	1 diseased area	95%	2 diseased areas	90%	3 diseased areas	90%
1 gram	3 diseased areas	90%	2 diseased areas	90%	2 diseased areas	90%	3 diseased areas	90%
2 grams	2 diseased areas	90%	1 diseased area	40%	1 diseased area	80%	1 diseased area	30%
4 grams	3 diseased areas	30%	3 diseased areas	10%	1 large diseased area	10%	2 diseased areas	10%
Check	4 diseased areas	100%	1 diseased area	100%	5 diseased areas	100%	4 diseased areas	100%

*The percentages given are for estimates of the area of seed-bed destroyed.

Judging from the results of the above experiments it would seem that two applications of 4 grams of copper carbonate, one before sowing the seed, and the other two weeks after germination might control the disease. It appears also that even 2-gram applications will be sufficient to control *P. debaryanum* (P 2).

Time of application and effect on disease control. In order to test the effect of Corona copper carbonate when applied at various times before and after seed sowing, eighteen flats, 7.5 ft. × 3 ft., were infested with *Phytophthora Parasitica* prior to treatment and seeding.

One set of three flats was selected as check and the remaining five sets of three flats each were treated in the following order: set No. 1 three weeks before; set No. 2 two weeks before; set No. 3, one week before; set No. 4 at time of sowing; and set No. 5 one week after sowing.

At the end of three weeks after germination the disease had appeared in all the flats and, therefore, a second application of four grams of the dust was made on all flats except the checks. The disease continued with great severity. The final observations were made two weeks after the second application and seedlings which still remained apparently healthy were removed and examined for lesions. Only those seedlings showing no lesions were classed as healthy. The percentage of healthy seedlings in the stand at the close of the experiment was as follows: set No. 1: 14.98, set No. 2: 12.44, set No. 3: 5.35, set No. 4: 11.09, set No. 5: 20.06, and

check 2.09. It should be noted that these figures do not represent the percentage of the original population. The figures of healthy seedlings on the basis of the latter would have been extraordinarily small.

The results show that there was no effect of time of application of dust on control. An only slightly but not significant favorable effect occurred when the dust was applied three weeks before the time of seed sowing. From these results it would seem that two applications of 4 grams of copper carbonate are not effective in the control of damping-off, a conclusion which is not in harmony with previous results.

Relations between amount of water and effect of treatment. With the purpose of determining the relation between different amounts of water and the effect of copper carbonate on seedlings, twelve flats (5 ft. $\times$ 3 ft.), protected from the rain by cell-o-glass frames, were treated with 3 grams of the dust and watered as follows:

Flats Nos. 1 & 5—1 gallon of water. Morning.
Flats Nos. 2 & 6—1½ gallons of water. Morning.
Flats Nos. 3 & 7—2 gallons of water. Morning.
Flats Nos. 4 & 8—2½ gallons of water. Morning.
Flat No. 9—1 gallon of water. Morning and afternoon.
Flats No. 10.—1½ gallons of water. Morning and afternoon.
Flat No. 11—2 gallons of water. Morning and afternoon.
Flat No. 12—2½ gallons of water. Morning and afternoon.

The quantities of water given are in each case for the entire flat, i. e., for 15 square feet of surface. It may be noted that the amount of water in the soil at the beginning of the experiment was not determined, but the soil was fairly moist.

The results may be summarized as follows:

(*a*) Better development of seedlings in flats 9 to 12 where two waterings were made than in the flats 1–8 (one watering).

(*b*) Flat No. 9 with only one gallon of water for each application, resulted in less germination and the seedlings made less progress than in any of flats 10, 11, or 12, but the seedlings were healthy.

(*c*) Flats 1 and 5 had very few plantlets, but they were healthy.

(*d*) Flat No. 11, two waterings every day, made a slightly better growth than flats 4 and 8 which received one watering of a little higher quantity.

(*e*) The last and most important—there was no injury from the copper carbonate in any of the flats.

Field Treatments

A series of treatments were made under field conditions making applications of the copper carbonate at the rate of four grams to the square foot of bed surface. These trials were conducted on various farms of the Cayey–Aibonito tobacco section. In none of these was the dust applied before seed sowing and always after the disease had made its appearance. The seed-beds chosen represent conditions of both high and low infection.

Conditions of light infection. Two seed-beds in Aibonito in which damping-off had appeared, were treated in October 1927 with the dust at the rate of four grams to the square foot. The disease was evident as small rotted areas here and there. One of the seed-beds had an area of a little more than 7,000 square feet; while the other was of about 4,200 square feet. These treated beds in each case were surrounded by other beds which received no treatment. When treatments were made the plants had reached the stage when leaves are the size of a half-dollar. The observations in both trials showed that the disease had not been checked and, therefore, a second application, at the same rate as the first was made two weeks later.

The results at the time when seedlings were transplanted showed no beneficial effects of the treatment. A general inspection of the series treated with copper carbonate and that without any treatment showed many diseased areas in the latter, where seedlings had been almost completely destroyed by the disease. On the treated beds these diseased areas were less numerous and, seemingly, smaller in extent. More definite results were obtained by making counts of seedlings removed from portions of the beds in the two series. Two contiguous beds, one treated and a check, were selected. Starting at the lower portion of the seed-bed and about ten feet from the end of the bed, a sector three and one-half feet wide by two feet in depth was marked off. At intervals of 15 feet three other sectors were measured in like manner. This was done for both beds, so that one sector in the treated bed corresponded to a sector in the check. The healthy seedlings existing in the beds at the end of the experiment were pulled and counted. The results were as follows:

Sector	Treated bed	Check	Difference
1	638 seedlings	306 seedlings	332 seedling
2	712 seedlings	508 seedlings	204 seedlings
3	617 seedlings	611 seedlings	6 seedlings
4	681 seedlings	708 seedlings	−27 seedlings

These differences were studied statistically by Fisher's method

for the determination of significance of differences of means, and odds of less than 2 to 8 were found, indicating very insignificant results. It must be concluded, then, that the treatment was ineffective. Objection may be raised to the value of these results and the conclusions therefrom, since the observations can be regarded as insufficient. Yet the odds obtained were so low that had a larger number of observations been made, the results would have been found to demonstrate ineffective treatment.

The efficiency of the treatment was, no doubt, influenced negatively by the extremely favorable conditions of atmospheric and soil moisture which prevailed, and by the large quantity of seed which had been sown (5 lbs. to the acre), which tend to favor the increase, spread, and severity of the disease. It may be added that some of the chemical may have been washed away by the rains.

Two other field trials of two four-gram applications were made in Cayey, one in the Model Farm and the other in a private farm. The treated portion of the first seed-bed was about 2,830 square feet. At the time of the first application the seedlings were about three weeks old and several areas of the disease had appeared in various places. The second application followed the first by ten days.

Counts were made in the first seed-bed because the disease did not spread from the original spots in the treated beds and it was thought that the general stand and freedom from lesions was sufficient to serve as a basis for conclusions on the effect of the treatment. The untreated beds suffered severely from the disease and no plants were used for planting. This experiment was considered a success.

In the second trial counts were made as described above except that sectors were marked off at intervals of 10 feet instead of fifteen feet, and eight observations instead of four were made. The results expressed as healthy seedlings were as follows:

Sector	Treated beds	Check	Difference
1.	232 seedlings	238 seedlings	−6 seedlings
2.	221 seedlings	307 seedlings	−86 seedlings
3.	532 seedlings	281 seedlings	251 seedlings
4.	813 seedlings	453 seedlings	360 seedlings
5.	691 seedlings	503 seedlings	188 seedlings
6.	447 seedlings	553 seedlings	−106 seedlings
7.	559 seedlings	564 seedlings	− 5 seedlings
8.	837 seedlings	684 seedlings	153 seedlings

These differences when studied statistically by Fisher's method were found to be insignificant, with odds of only slightly over 4:1.

The treatment, according to the results of two experiments, was

unsuccessful while a checking of the spread of the disease was obtained in one experiment. Whether the conditions of infestation were higher in the check beds of this experiment where control was secured was not determined at the time the experiment was begun, but the random selection of the beds is in favor of the view that this did not happen. It may be concluded that the evidence from three field trials with copper carbonate applied to beds where there is slight infestation of the disease agents, shows that the treatment is unsuccessful.

Conditions of heavy infection. A section of a tobacco seed-bed (about 6,000 square feet) on a hillside in Cayey, with a severe infection of damping-off (about 40 per cent of the bed destroyed) was dusted with copper carbonate at the rate of four grams per square foot of surface. The results were unsatisfactory, probably due to the fact that the treatment was made when the disease was well advanced. It should be added that heavy rains prevailed during the time before and after the application of the dust.

Effect of Copper Carbonate on damping-off of vegetables

In the autumn of 1927, twenty-eight six-foot rows of young seedlings of tomato, eggplants, and pepper were found to be affected with damping-off, which proved to be caused by *P. debaryanum.*

The beds were dusted with copper carbonate at the rate of 4 grams per square foot as soon as the disease was discovered. A second application of the dust was made a week after the first. Daily observations were made henceforth until the time of removal of the plants to the field. The disease was checked by the treatment.

To check up these results, an experiment was planned in beds 20 ft. $\times$ 3 ft. where the soil was a rich loam which had received a light application of cottonseed meal. The soil was infested with cultures of *P. debaryanum* from tobacco. A week later an application of 4 grams of copper carbonate per square foot was well raked into the surface soil. Three beds were employed and each was divided into three subdivisions with partitions which were sunk ten inches below the surface of the soil. The middle portion in the outer beds (1 and 3) and those on the ends of bed No. 2 were left untreated. Eggplant, tomato, and pepper seed was sown in alternate lengthwise rows 4 inches apart in all the beds, except the last section of the third bed, a week after the treatment was made. The order of planting was tomato, eggplant, pepper; and the treated bed sections were planted first and later the checks, so that the rows in one series should correspond with those in the other. There were a total of eleven

rows of tomato and eggplant and 10 rows of pepper in each series; but notes were taken on 10 rows of each. The rows in the check beds were 7 feet long, those in the treated beds, 6.5 feet long; but seedlings were thinned out and only 300 of eggplant and 400 of pepper and tomato were left in each row. Germination was normal in all beds but some of the seedlings in both treated and untreated beds showed symptoms of the disease two weeks after germination. The disease became more serious and a second application was deemed necessary. A week after the first symptoms of the disease appeared, the second application (4 grams per square foot) was made. The disease continued for four days longer when a few seedlings were found to show symptoms. A week later no more seedlings were found dying. However, in the untreated beds the disease increased in severity. Records were taken of the total number of seedlings affected by the disease. Final observations were made when the seedlings were of transplanting age. The results are given in the following table.

TABLE 2

SHOWING RESULTS OF TREATMENT OF SOIL INFESTED WITH *P. debaryanum* WITH TWO FOUR GRAM APPLICATIONS OF CORONA COPPER CARBONATE

Bed Number	Tomato			Pepper			Eggplant		
	Healthy	Diseased	Per cent Healthy	Healthy	Diseased	Per cent Healthy	Healthy	Diseased	Per cent Healthy
1 Treated	1,011	189	84.25	1,107	93	92.25	574	26	95.67
2 Check	75	1,125	6.25	255	945	21.25	136	464	22.67
3 Treated	1,116	84	93.0	714	86	89.25	804	96	89.33
4 Check	93	1,107	7.75	94	706	11.75	114	786	12.67
5 Treated	654	146	81.75	1,155	45	96.25	777	123	86.33
6 Check	86	714	10.75	213	887	17.75	198	702	22.00
7 Treated	602	198	75.25	782	18	97.75	552	48	92.00
8 Check	34	766	4.25	162	638	20.25	154	446	25.67

In order to study the significance of the differences between treated and check beds the results expressed in percentages were paired so that a comparison was established between tomato from the treated beds and tomato from the checks; the same for pepper and for eggplant. Such a study showed that the differences were highly significant, the odds for tomato being well above 4999 : 1, for pepper over 9999 : 1, and for eggplant nearly 9999 : 1, when Student's method was employed. It can be safely concluded from the above data that two applications of 4 grams of copper carbonate applied as described above, will control *Pythium debaryanum* on tomato, pepper and eggplant.

That this treatment was more successful than those on tobacco

may be attributed to the less crowded conditions in the beds with the vegetables. In the latter the sun's rays reach down to the soil at least during the early susceptible stages of the development of the plant and help in drying up the surface layer. This drying up probably also is a factor in disinfestation.

Copper stereate

An experiment was carried out to determine the effect of copper stereate on the control of damping-off. Of fifteen flats (2½ ft. × 3 ft.); five were infested with oatmeal agar mass cultures of P 1, five with P 2, and five with P 3. One flat of each set was left as a check. The remaining four flats of each set were treated one each with 1, 2, 4, and 8 grams of the chemical per square foot, respectively. The seed was sowed a week later. Two weeks after germination damping-off had started in all the flats and therefore a second application was made.

When final notes were taken it was plain that the treatment had been ineffective in controlling *P. Parasitica* (P 1 and P 3) while apparently some control of *P. debaryanum* (P 2) as suggested by healthy seedlings, had been obtained when two applications of 8 grams per square foot had been applied.

A second experiment was conducted in which *P. debaryanum* (P 2) alone served as the damping-off pathogene. Three beds 20 ft. × 3 ft., were employed, of which two were treated with copper stereate at the rate of 8 grams per square foot and the third was left as a check. The seed was sowed a week after the application. Symptoms of the disease were evident ten days after germination, when a second similar application was made. The disease continued unchecked in all the beds and extended to the majority of the seedlings before these had reached transplanting age.

It is concluded that copper stereate is ineffective in the control of the disease.

Uspulun

It was felt that treatment with organic mercury compounds might prove advantageous. Several experiments were made with Uspulun solutions of different concentrations.

In the first experiment three sets of five flats (2½ ft. × 3 ft.) were employed. The soil was infested with P 1, P 2, and P 3 isolates respectively. One flat from each set was selected as a check and the remaining treated each with the following concentrations of Uspulun: 1–300, 1–600, 1–1200 and 1–2400, one week before seed

sowing. The solutions were added in sufficient quantity to soak the soil.

Germination was normal in all flats except those treated with the 1–300 solution in which injury to the seedlings was very evident.

Symptoms of the disease appeared in all flats at an early stage and destruction was complete by the third week in all flats treated with the 1–200 and 1–2400 solutions. A second application was made on the 1–300 and 1–600 flats and this was followed ten days later by a third application. The disease continued unchecked.

The second and third 1–300 applications were injurious to the foliage. The results of this experiment showed that even three applications of a 1–300 Uspulun solution do not control tobacco damping-off.

A second experiment was devised with a 1–400 solution, using different quantities per square foot of surface. Four beds (20 ft. × 3 ft.) previously infested with cultures of the pathogenes, were treated a week before seed sowing and with a 1–400 solution, one each with ¼, ½, and one gallon per square foot, respectively, and the fourth was left as a check.

Germination was perfect in all the beds except that receiving the 1 gallon application, in which very few seedlings developed. The disease appeared in the beds and therefore a second application was made the third week after germination. This did not check the spread of the disease so that at the close of the experiment, three weeks after the second treatment, nearly all the plants had died. (See plate XXXII.)

It may be concluded that a 1–400 Uspulun solution at the rate of 1 gallon per square foot is injurious to seed germination, while at the rate of ¼ or ½ of a gallon it is effective in controlling the disease.

Bayer dust

A preliminary experiment was started with Bayer dust, an organic mercury compound. Four sets of five flats (2½ ft. × 3 ft.) were infested with Pythium and Phytophthora cultures one each with P 1, P 2, P 3, P 10 and P 13. In each set one flat was treated with Bayer dust at the rate of ½ gram, one with 1 gram, another with 2 grams and the fourth with 4 grams per square foot, while the fifth was left as a check. The seed was sown a week after treatment.

Germination was normal in all the flats. The first symptoms of the disease appeared three weeks after germination in all flats. A second application was then made.

The results at the termination of the experiment six weeks after germination, showed that Bayer dust was effective in the control of damping-off even when as many as two applications of four grams per square foot were employed.

The ineffectiveness of this treatment was further shown in an experiment with two four-gram applications of the dust. The beds used were 20 feet × 3 feet and infested with a mixture of oatmeal agar cultures of *P. debaryanum* and *P. Parasitica.* The first application was made a week before sowing the seed and the second was made two weeks after germination. Three beds were treated and one was left as a check. The results showed a complete destruction of the seedlings in the check as well as in the two treated beds. (See plate XXXIII.)

In order to determine if seedlings could be better protected by applications after germination only, the preceding experiment was duplicated using this time the 4 gram treatment only and making two applications, one a week after germination and the other following the first by 10 days.

At the close of the experiment no significant difference between treated and check flats could be found, indicating the non-effectiveness of the Bayer dust.

Copper sulphate

Three beds (20 ft. × 3 ft.) were infested with a mixture of oatmeal agar cultures of P 1, P 2 and P 3 and after a week treated as follows: one with a solution of 2 pounds of copper sulphate in 25 gallons of water, the second with 2.5 pounds in 25 gallons, and the third was left as a check. The third bed was located between the first and second. The rate of application in the two cases was 1 gallon per square foot. Seed was sown a week after application.

Two weeks after germination there was a general occurrence of damping-off in all the beds and the disease continued until only a few scattered plants were left. This indicates the failure of copper sulphate at those concentrations to eradicate the damping-off fungi.

Copper fluosilicate *

Four beds (20ft. × 3 ft.) were prepared as in preceding experiments and infested with a mixture of cultures of *P. debaryanum* and *P. Parasitica.* Three were treated one each with 2, 3 and 4 grams of the dust, respectively, per square foot. The fourth bed was kept as a check. Seed was sown ten days after treatment.

* The copper fluosilicate compound used in this experiment is not manufactured any longer.

A second application of the dust was made three weeks after germination when it was clear that the disease was making headway in all the beds. The dust from the second treatment produced a burning of the foliage of a large number of seedlings but checked the disease in the beds receiving three and four-gram applications. (See plate XXXIV.)

In conclusion, it may be said that copper fluosilicate did not have a deleterious effect on the germinating seedlings. When applied after germination it burned the foliage of the plantlets. Two applications of 2 grams per square foot were not enough to control the disease. Two applications each of 3 and 4 grams of the chemical, one a week before sowing the seed, the other four weeks after seed sowing gave good control.

Acetic acid

Three beds (20 ft. × 3 ft.), where tobacco seedlings had died from damping-off, were treated as follows: No. 1 with one per cent acetic acid, and No. 2 with 1.2 per cent acetic acid, both at the rate of one-half gallon per square foot, while the third bed remained untreated. The concentrations used here are those used by Doran (13) and which he gives as resulting in good control of the damping-off of tobacco.

The seed was sown ten days after treatment.

The observations made after germination showed that the disease appeared twelve days after germination and progressed rapidly until the experiment was terminated when it had spread completely over all the seedlings as in the case of the check bed. The failure of acetic acid to control the disease in Puerto Rico under conditions of high infestation is clear.

Bordeaux mixture

Since Bordeaux mixture had been reported as giving good control in Puerto Rico and Cuba it was deemed desirable to make tests with it under controlled conditions. For this purpose three of the common formulas were used, namely, the 3–3–50, 4–4–50, and 5–5–50. Eight beds (20 ft. × 3 ft.) which were heavily infested with cultures of the pathogenes were treated, two each with each formula and the remaining two were left untreated. The rate of application was one-half gallon per square foot. Seed was sown a week after the treatment.

Germination was excellent in all beds. Two days after germination a few small areas of the disease were observed, and then a

second application at the same rate and formula as the first was made on all the treated beds.

The results show complete damping-off of seedlings in the check beds, about 25 per cent infection in the 3–3–50 beds and about 5 per cent infection in the 4–4–50 and about 5 per cent in the 5–5–50 beds. (See plates XXXV and XXXVI.)

From these results it may be concluded that two applications of 4–4–50 or 5–5–50 Bordeaux mixture, at the rate of ½ gallon per application per square foot, serve as good protectants against damping-off. These applications should be made one before sowing the seed and the other ten to fourteen days after germination.

A further test was made with Bordeaux mixture (4–4–50), on five beds on which the disease had appeared. The diseased areas were treated with 1–30 formaldehyde and then the first application of the bordeaux mixture was made at the rate given in the preceding experiment. The disease continued to spread over the beds so that a second application was made two weeks later.

These beds were exposed to heavy rains so that some of the mixture was undoubtedly washed away.

The results showed that the disease was not completely checked by the two treatments but the treated beds showed a great improvement over the surrounding untreated beds where all the plants were affected.

It may be concluded from these results that applications of Bordeaux mixture (4–4–50) after the disease has made its appearance in a seed-bed do not check completely any further spread though it reduces the amount of disease.

Injury from copper fungicides

In an experiment made in 1927 on beds in the field, where a crop of tobacco seedlings had previously been grown, it was found that injury resulted from an application of cooper carbonate. This is the first case of injury from this compound in any of our experiments. Six beds (120 ft. × 4 ft.) had been treated with the dust at the rate of four grams per square foot, one week before seed sowing. The beds were well watered during all the time the experiment lasted. It should be added that the neighboring beds, making a total of about one acre, were treated with 1–50 formaldehyde at the usual rate.

The injury in the copper carbonate-treated beds was manifested in much delayed germination and the few seedlings that developed

were stunted and yellow. No injury resulted from the formaldehyde treatment under the same conditions.

The injury of the compound was not due to a too heavy application since it was the same as employed in all previous experiments with the same dust, in which no injury ever resulted. It can not be attributed to dryness since the beds were liberally watered twice a day.

An experiment was planned in 1928 in order to find out whether such deleterious action could be prevented. The conditions of the preceding experiment were duplicated as nearly as possible. A seedbed, on the same kind of soil (a heavy loam), which was growing a crop of tobacco seedlings was selected. It was assumed that the injury occurred either because too much copper became soluble or because some compound or substance was formed on these soils which was injurious to germination. The beds were cleaned in December, the soil reworked, and an application of a 6–7–8 fertilizer (nitrogen in the form of sulphate of ammonia and cottonseed meal) applied.

Besides copper carbonate, Bordeaux mixture was also used in the experiment. As checks to the copper disinfestants, acetic acid and formaldehyde were employed, the latter because no injury had followed this treatment on the same soil where copper carbonate had been injurious and the former because of the change in soil reaction which would be expected with its use. Charcoal was used as an absorbent.

The beds were 40 ft $\times$ 4 ft. and they were protected from insolation by a cheese-cloth shade. There was very little rain during the time the experiment was in progress so that it may be said that all the beds alike received a moderate amount of water. Watering was done once a day, in the morning. Soil samples for the determination of active acidity were taken a week before the application of the fungicides and again at the time injury first appeared in some of the beds.

The charcoal used in the experiment was very finely ground; it was applied at the rate of 1 ounce per square foot of surface on January 8. The disinfestants were applied January 11 at the following rates per square foot: copper carbonate, four grams; Bordeaux mixture (4–4–50), ½ gallon; acetic acid (1.2 per cent), ½ gallon; and formaldehyde (1–50), ½ gallon. Both the charcoal and the copper carbonate were incorporated by raking them well into the loose surface soil. The liquid solutions were applied with sprinkling cans.

The seed was sown in all beds January 24, 1929. The arrangement of beds, treatments, and results appear on Table 3.

TABLE 3

SHOWING EFFECTS OF CHARCOAL ON COPPER CARBONATE AND BORDEAUX MIXTURE - TREATED BEDS; ALSO EFFECT OF ACETIC ACID AND FORMALDEHYDE; SOIL OF OLD BEDS

Beds	Treatment	Results
1	Check	Normal development
2, 3	Charcoal alone	Normal development, slightly lower than check
4, 5, 6	Copper carbonate plus charcoal	Yellowing of seedlings; about 25 per cent of plants
7, 8, 9	Copper carbonate alone	Yellowing of seedlings; about 25 per cent of plants
10, 11	Checks	Normal development
12, 13, 14	Bordeaux (4–4–50) plus charcoal	Slight yellowing on about 5 per cent of plants
15, 16, 17	Bordeaux (4–4–50) alone	Slight yellowing on about 5 per cent of plants
18, 19	Checks	Normal development
20, 21	Acetic acid (1.2%) plus charcoal	Normal development; like checks
22, 23	Acetic acid (1.2%) alone	Normal development; growth more rapid than in check
24	Check	Normal development
25, 26	Formaldehyde plus charcoal	Normal development
27, 28	Formaldehyde alone	Normal development; more rapid than in checks; similar to beds treated with acetic acid
29, 30	Charcoal alone	Normal development; slightly slower than checks
31	Check	Normal development

It is plain that charcoal did not prevent the injurious action of copper carbonate and Bordeaux mixture. The fact that Bordeaux mixture was also injurious to seedlings grown under the same conditions as those of beds treated with copper carbonate or with no treatment at all, seems to indicate that copper is the toxic agent. Beds treated with formaldehyde and those with acetic acid were not only normal but the stand of seedlings and rapidity of growth surpassed that of the non-treated beds. Development in the beds treated with charcoal alone was slightly slower than that of the non-treated beds. This action of the charcoal was evident when beds treated with acetic acid or formaldehyde, with and without charcoal were compared. Growth was much more rapid where charcoal was not used.

It seems likely that the cause of the injury by the copper compounds can be attributed to some chemical reaction with the soil. The object of this experiment has not been to determine, through the proper chemical procedure, the real nature of the toxicity in question. Therefore, we shall point out only the probable cause or causes which the results in table 3 suggest. The favorable effect of formaldehyde and acetic acid as contrasted with the rather injurious tendency of copper carbonate and Bordeaux mixture, suggests that the latter treatments have alike induced a certain reaction to which may be attributed the injury produced on seedlings. The pH reaction of the soil may directly have little to do with these results. On discussing the general effect of the various treatments we can

draw the following considerations. The disinfesting action of formaldehyde and acetic acid is only temporary. Therefore, as they do not prevent secondary infestations their use is undesirable. It is obvious that the beneficial soil flora will regain its predominance without much difficulty. On the other hand, the disinfesting properties of copper carbonate and Bordeaux mixture are more lasting and it may be possible that the nitrifying organisms in the soil may cease to increase in numbers and their action be reduced. Were this to occur the whole question might be referred to nitrification. The condition of the seedlings would suggest starvation of some kind. Now, according to this assumption, the injury in the beds treated with the copper compounds occurs because nitrification is prevented. In those not so treated or where either acetic acid or formaldehyde were applied, nitrification proceeded after the treatment. That this injury does not occur in new land or in soils not previously growing a tobacco seed-bed, may be given further in support of this assumption. A soil in which a tobacco seed-bed has been growing is almost depleted of its nitrates as evidenced from the failure of a second crop immediately following the first. The success of the second seed-bed, then, depends entirely on the nutrients rendered available during the time it is in progress. If any difficulty arises whereby these nutrients are prevented from being incorporated in an available form, the failure of the crop may be expected.

In an experiment conducted in flats in the greenhouse in the fall of 1931 injury from Bordeaux mixture was again observed. Two flats were sprayed weekly for three weeks with a sodium nitrate solution (1 ounce to 1 gallon). The majority of the seedlings recovered and made normal growth. No further experiments were carried out and these results must, therefore, stand only as a suggestion for more controlled experiments.

In connection with injury resulting from copper it may be added here that Mme. Vladimirskaya (30) in studies on the action of various methods of soil disinfestation upon the physical and chemical constitution of the soil, found that among other substances copper carbonate had a deleterious effect on nitrification. She further found that formaldehyde at first suppressed but later stimulated the development of the nitrifying flora of the soil. Our results and observations appear to be in line with her results.

Summing up, in our opinion it may happen that the fertilizer added to a soil which is later treated with a disinfestant of lasting effect, is not rendered available and therefore the seedlings can make no use of it.

Effect of cultivation

It was thought that constant cultivation for a period of five or six months might reduce the amount of infestation in a soil. If possible this would be a practical means of eradication which farmers in Puerto Rico would not hesitate in putting into effect.

An experiment was started in 1928 with a view of ascertaining the effect of cultivation. Two beds, where some chemical treatments had been unsuccessful, were chosen because these were known to be heavily infested. In one of the beds subdivided into three sections, copper sulfate and Uspulun solutions had failed to control the disease and in the second bed Bayer dust and mercuric chloride had been unsuccessful in experiments which lasted until March 26. A third bed which had had damping-off all the time was selected as a check. The size of the beds was 20 ft. $\times$ 3 ft.

This experiment was begun on April 15. The three beds were sown on that date, because we wanted to know the degree of infestation of the beds at the time the experiment was commenced. The germination in the beds was excellent but damping-off began to appear on the young seedlings soon after they emerged. All the seedlings had been killed by May 10, when two of the beds were weeded and the soil loosened up well with a spade and rake. The third bed was left unweeded throughout the time the experiment lasted. The two treated beds were weeded twice a month when the soil was again loosened up. This continued until Nov. 15, when the check bed was also weeded and the soil put in shape for the sowing of the seed. There was good germination in all the beds. Damping-off appeared in the three beds simultaneously on Nov. 26, and spread very rapidly. On Dec. 6 more than 76 per cent of seedlings had been killed in each of the three beds and destruction was complete by Dec. 10.

The results show that about six months of constant cultivation of an infested soil does not reduce the amount of infestation of the damping-off pathogenes.

To test whether the treatment would be efficacious over a period longer than six months, the same beds were similarly treated from Dec. 10, 1928 to Dec. 10, 1929. The seed was again sown. The disease appeared again. When the experiment was closed, i. e., when plants were of transplanting size, not less than 60–70 per cent of the stand had been destroyed by the disease, which shows that even a year of continuous cultivation fails to eradicate the disease.

This experiment was not conducted over a longer period because

it was realized that even one year of such a treatment would be highly impractical in Puerto Rico.

Protection

The experimental part on protection has been given with that on eradication. In tobacco damping-off, it appears that a definite, clearly cut line cannot be drawn between protection and eradication. They are, in our minds so linked to each other that a discussion of the data separately would detract very much from the value and meaning of the same.

With the eradication of the damping-off pathogenes naturally goes the destruction of the majority of the organisms constituting the soil flora, thus breaking the equilibrium which must normally exist among these soil inhabitants. A reinfestation by the pathogenes causing damping-off may rapidly gain a foothold in the new habitat, the fungi spreading with much rapidity. Tobacco seedlings, under the conditions of moisture and temperature characteristic of those overcrowded plant populations, and with their high susceptibility offer these pathogenes the most favorable abode. It is clear that some means of insuring the best development of the seedlings must be provided. A barrier, therefore, must be erected between the susceptible plant parts (leaf, stem, and roots of seedlings) and the parasite. This may consist of some substance which when applied to the parts susceptible of penetration will kill the inoculum. Such a substance may also be applied to the environment where the pathogene is harbored or where it may extend into, checking its progress there. This aim might also be attained by modifying other external conditions or factors which influence the development, spread and severity of the disease.

Methods of protection to follow those of eradication have already been discussed in relation to the disinfestation experiments. It was found that copper dusts or compounds when applied to the soil and plants will protect the latter considerably from new attacks. The best methods of control are those which combine the means whereby the amount of inoculum in the soil is reduced to the minimum and which insures a relative amount of protection thereafter.

A discussion of other protective measures for seed-beds against damping-off may be found in the literature. The application of a layer of dry or hot sand to the surface of the beds after the seed is sown will give good results in connection with the damping-off of other seedlings like citrus and vegetable garden crops; but with to-

bacco, the seed of which is very small, it will probably be inapplicable, aside from being too costly on a large scale. It seems that the avoidance of organic matter, especially fresh barnyard manure, will do much good in preventing the disease. Yet a clean bed when enriched by the addition of uninfested manure will be as safe as any other soil, and, besides, will give strong, rapidly developing plants. Any uninfested seed-bed may be protected from infestation by digging a wide trench or ditch on all sides and especially on that side from which the drainage water is expected to run. This ditch must be wide and deep enough to take care of all the superfluous surface water during heavy rains. It should drain away from the seed-bed, and under no circumstances should lateral ditches be allowed to drain through the beds.

Great damages will be prevented sometimes by clean and careful culture. Weeding should be done as carefully as possible. There is often more harm resulting from careless weeding than the good which should follow the removal of the weeds. Before proceeding to weed a field a careful inspection of the bed should be made and wherever symptoms of the disease are detected the diseased areas should be drenched with a 1–30 formaldehyde solution. This done, the beds may be weeded without danger, unless the pathogenes have already spread too far away from the treated areas at the time these were detected. It is always a good practice to apply the disinfestant even beyond the zones of infection. Persons handling diseased plants should wash their hands in a disinfecting solution, then in water before going into healthy beds. Any tools used in such beds should be sterilized in a formaldehyde solution before using them in other beds. Wet, low places in seed-beds are usually a source of inocula. The disease will first appear here and the inoculum is then transported by the many agents into other beds. All such wet spots should be avoided when looking for a suitable site for the beds. When they cannot be avoided they should be drained well and the drainage ditch should empty into the outside. Pools of water should not be allowed to form in the ditches because they are often the sources of inocula.

Summary

1. Damping-off of tobacco is a very severe disease in Puerto Rico.

2. The disease is caused by *Pythium debaryanum* and *Phytophthora Parasitica* var. *nicotianae*.

3. The agents of transportation of the fungus are water currents, laborers, animals, burrowing insects, etc.

4. Leaves are infected by zoospores of *Phy. Parasitica* var. *nicotianae* but apparently not by those of *P. debaryanum.*

5. Environmental conditions are important factors influencing the spread and severity of the disease. The disease seems to be equally severe during all seasons provided the proper moisture relations are maintained. Organic manures seem to influence favorably the incidence of the disease. The disease is severe on thickly-sowed beds.

6. Control of damping-off of tobacco is today one of the most serious problems with Puerto Rico tobacco growers.

7. When the disease appears in small areas only, it may be checked by drenching these with a 1–30 formaldehyde solution.

8. Soil disinfestation by means of steam or with formaldehyde does not seem to be practicable under Puerto Rican conditions.

9. *Phy. Parasitica* var. *nicotianae* is probably slightly less susceptible to the sterilizing action of formaldehyde than *P. debaryanum.*

10. Mercury compounds have been found injurious to tobacco seedlings, and ineffective against the damping-off pathogenes.

11. In preliminary trials two applications of Corona Copper carbonate of four grams per square foot, before seed sowing, and at the same rate a week after germination, were fairly effective.

Two applications of copper carbonate in the field did not give effective control probably due to the heavy rains and to overcrowding of the seedlings. Two late applications of copper carbonate on heavily infected beds were unsuccessful. Two 4-gram applications of copper carbonate resulted in good control of the damping-off of tomato, pepper, and eggplant.

12. Copper stereate, in two applications of 4 grams each, seemed to control *P. debaryanum* but did not have any effect on *Phy. Parasitica* var. *nicotianae.*

13. Bayer dust and Uspulun were injurious when applied to the foliage and proved to be ineffective in the control of the disease.

14. Copper sulfate solutions (4 and 5 pounds to 50 gallons), applied at the rate of ½ gallon per square foot before sowing the seed were ineffective.

15. Effectiveness of copper fluosilicate is doubtful.

16. Acetic acid does not control the disease under conditions of high infection.

17. Two applications of 4–4–50 and 5–5–50 Bordeaux mixture at the rate of ½ gallon per square foot, one before sowing the seed and the other a week after germination, were effective in controlling

damping-off. The treatment was not very successful when applied to beds in the field in which the disease had made its appearance.

18. Injury to seedlings resulted when copper carbonate was applied to a tobacco seed-bed on the site of an old bed. It was proved by experiment that the injury was not due to dryness. Soil reaction appears to have little to do as a direct cause of the injurious action. No injurious action of formaldehyde or acetic acid was found under similar conditions. Charcoal was not effective in preventing injury from the copper compounds. Recovery from injury resulted in one case when a sodium nitrate solution was applied. It is suggested that the injurious action is connected with nitrification which would be hindered by the lasting effect of the copper treatments.

19. Continuous cultivation of infested soils for periods of six to twelve months does not eradicate the disease.

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Explanation of Plates

Plate XXVII. Healthy tobaco seedlings.

Plate XXVIII. Tobacco seedlings showing lesions produced by infection with *Phythium debaryanum.* Note that they are confined to the region of the stem at the soil surface.

Plate XXIX. Tobacco seedlings infected with *Phytophthora Parasitica.* Note that the lesions may occur higher up the stem than the surface of the soil.

Plate XXX. Bed treated with four grams of copper carbonate (Corona) at the time of seeding and two weeks after germination.

Pate XXXI. Another bed treated with four grams of Corona copper arbonate a week before seeding and two weeks after germination.

Plate XXXII. Bed treated a week before sowing seed with a 1–400 Uspulun solution at the rate of one-half gallon per square foot of surface.

Plate XXXIII. Bed treated a week before sowing the seed, with Bayer dust at the rate of 2 ounces per square yard. Note the complete destruction of seedlings with only a few at the lower corners surviving.

Plate XXXIV. An application of four grams of copper flousilicate made after the appearance of the disease resulted in good control though in injury to many seedlings.

Plate XXXV. Two applications of Bordeaux mixture (4–4–50) at the rate of one-half gallon per square foot, one at the time of seeding, the other two weeks after germination. Note the stand and vigor of the seedlings.

Plate XXXVI. Two applications of 5–5–50 Bordeaux mixture, one at the time of seeding, the other two weeks after germination. Rate of application, one-half gallon per square foot of surface.

Plate XXXVII. An infested bed from the checks. Note the almost complete destruction of seedlings. The majority of the seedlings showed infection at the time the photograph was taken.

PLATE XXVII

PLATE XXVIII

PLATE XXIX

PLATE XXX

PLATE XXXI

PLATE XXXII

PLATE XXXIV

PLATE XXXV

PLATE XXXVI

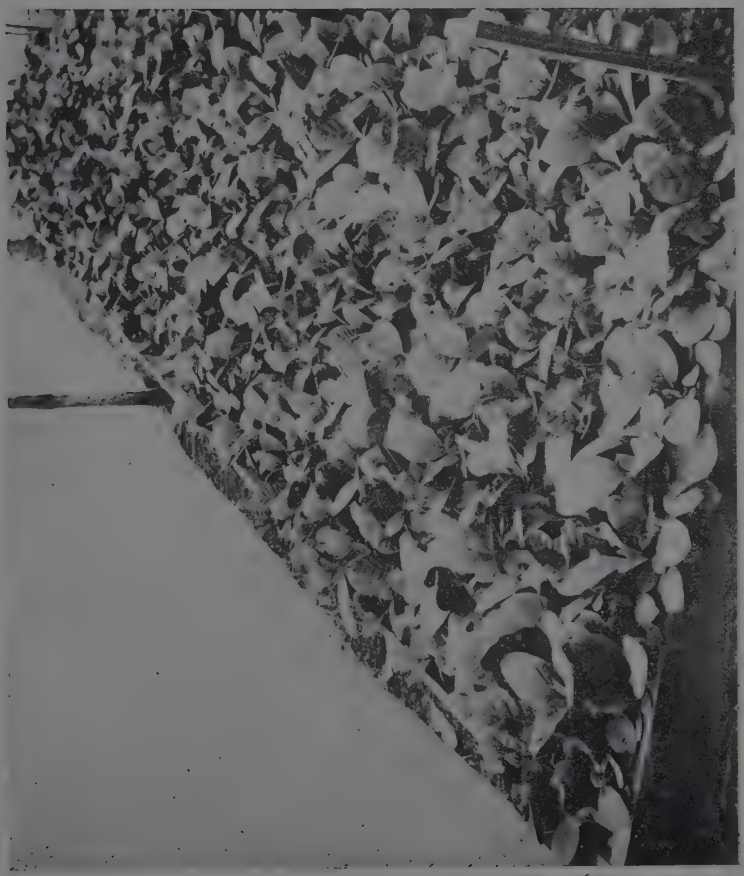

PLATE XXXVII

A NEW FROG FROM THE VIRGIN ISLANDS,

CHAPMAN GRANT, *Major, U. S. Army.*

A recent ten-day collecting trip to St. Thomas, St. John, St. James and adjacent keys developed several new locality records and one new frog which may be called:

Eleutherodactylus cochranae sp. nov.

Type No. 5659. Chapman Grant Collection, 14 April, 1932, St. John Island, V. I.; collector, Chapman Grant.

Diagnosis: Distinguished from the other West Indian *Eleutherodactylus* by practical absence of vomerine teeth; short obtuse snout; small size of ear and its nearness to eye.

Habitat: St. John and Hassel Island, St. Thomas. Found in the axils of *Bromeliads.*

Proportions: Slender, medium size, 20 mm.

Description of Co-types: Habitus average, head slightly wider than body, eyes medium; limbs medium, relatively short, heels overlapping when legs are placed at right angles to the body; length vent to heel equal to about vent to posterior part of eyes. Vomerine teeth almost wanting. Tongue large, oval, not notched behind, free about half its length. Nostrils prominent, much closer to tip of snout than to eye; canthus rostralis not distinct, loreal area sloping, longitudinally concave, indistinct because of warty skin in this area; snout short and obtuse; distance between orbits about ¾ width of eye and about equal to eye to half way between nostril and snout; eye medium but equal to distance eye to snout; tympanum small, not distinct above, about ⅓ diameter of eye and nearly adjoins the orbit; fingers free with medium discs graduated, smallest on first finger; area of disc on fourth finger twice that of first; toes with medium discs, fourth and fifth decidedly larger than other three; no webs; tubercles small. Skin coarsely granular on belly which bears a disc, and on lower aspect of thighs; raised line from snout to vent, large warts on head and eyelids symmetrically placed and about five rows warts along dorsum; largest toe disc almost equal to tympanum in area and slightly larger than largest finger disc.

Color and markings: Above generally grayish brown with a complicated dark brown pattern, resembling the outstretched skin of a

wolf; usually a dark stripe from eye, over tympanum and front leg; rear aspect of thigh and lower surface of tibio-tarsal joint clear seal brown. Below light with fine brown specks on throat and thighs, belly nearly clear.

Measurements of type, which is an average adult: snout to vent 21 mm.; width of head 8 mm.; snout to posterior edge of tympanum 8 mm.; leg from vent 26 mm.; foreleg from axilla 12 mm.; hind foot 10.5 mm.

This species is found in the axils of tree-inhabiting *Bromeliads*. Thirty or more individuals sometimes being found in one plant. A very few *E. antillensis* were found with these on St. John but none on Hassel Island. This species has certain resemblances to *E. antillensis*, but many *E. antillensis* smaller than many of the present species had their own characteristics well marked. There seem to be many constant differences but the granulation of the lower side is similar.

I submitted this question to Miss Cochran who writes under date of July 12, 1932, "_____ is certainly not the young of *antillensis*. It has no well marked canthus rostralis, its snout is shorter, its ear is considerably nearer to the eye, it has practically no vomerine teeth, and it has no well-marked black reticulations behind the femur—in all of which characters it is decidedly different from *Antillensis*".

The voice of this species was not heard.

Remarks: Specimens taken, St. John, 210; Hassel Island, 45.

Named in honor of Doris M. Cochran.

This frog bears a superficial resemblance to *E. gryllus* of Puerto Rico in color and markings, but the head is wider in proportion.

NOTES ON THE BOAS OF PUERTO RICO AND MONA

CHAPMAN GRANT, *Major, U. S. Army.*

The two species herein treated seem very different in general aspect but show considerable similarity in squamation. The markings are really the surest and easiest means of identification, since most scale-counts overlap.

Dorsal spots neck to vent_____ 70–80—*Epicrates inornatus.*
Dorsal spots neck to vent_____ 51–60—*Epicrates monensis.*

The postoculars of *E. inornatus* are 4 or rarely 3. Of *E. monensis* 7 or rarely 6.

Epicrates inornatus (Reinhardt)

Very few specimens of this species have been preserved in collections, there being only about half a dozen in the United States. Stejneger describes the type and variations in a scholarly manner in "The Herpetology of Porto Rico". To his description is added the fact that the lining of the mouth and the tongue are black and the eyes of the young are bronze color.

The first specimen of my collection came from high up on Luquillo mountain. It is dark and of so uniform a color that the dorsal spots cannot be counted. Length 6′. The next two specimens were from the headwaters of the Mameyes River. Taken May 17, 1931. They mated the same day while being transported in a box. They would not eat, although a roomy cage with shelter was provided. Every imaginable food was offered them—small, live rabbits, small live chickens, live *Anolis*, cockroaches, milk, meat, fruit, eggs, etc. Finally they assimilated beef when force-fed. Upon being killed, July 20, 1931, the female was found to contain 32 embryos in capsules 54 × 30 mm. The embryo being 90 mm. long, the body 4 mm. wide, the head like a bird's, almost spherical and about 6 mm. in diameter, the eye 3 mm. in diameter, pigmented. The markings on these two adults are very clear, there being about 73 dorsal spots, decidedly and clearly outlined with very dark brown, the center light walnut color but darker than the brown body color. Length 5′9″ and 6′ respectively. Another specimen from near the City of Río Piedras 2′10½″ long is a light tan color. In distinction to all other specimens seen the dorsal spots, 78 in number, are lighter instead of darker than the body color, with a suggestion of a darker border.

Hence, light instead of dark spots are counted on this specimen. A postocular dark line is prominent in this specimen. The fifth specimen, 370 mm. long, is one of a litter of 18, of which more may have escaped un-noticed, born in captivity at Río Piedras, in the possession of Mrs. T. J. Haydon. She had no success in feeding the young which all escaped or starved. It is impossible to count accurately the dark spots on this specimen because they are so broken up, but there appear to be about 70. One of her adults constricted a guinea pig but would not swallow it.

This boa appears to be entirely inoffensive and strikes only when hurt. On the defensive, it frequently ties itself into a ball with the head entirely hidden within the folds of the body. It hisses loudly and can strike with open mouth about one half the length of the body from a gathered position. It does not "coil".

I have measured several skins and several poorly mounted and alcoholic specimens and find none over 6′6″ long, although stories persist of larger specimens.

This snake is partly arboreal, being frequently found in trees. When disturbed, it descends and enters a hole at the base of the tree or makes for rocky places. It is apparently a nocturnal feeder but basks in the early sun before retiring to its lair. The lairs may be distinguished by the strong odor.

Amaral (1) has synonymized this species with *E. subflavus* Stejneger. Stull (2) makes the following remarks: "Doctor Amaral has obviously treated the South American members of this group, with which he is thoroughly familiar and of which he has examined large series of specimens, in a manner quite different from his handling of the West Indian forms, which are almost entirely unrepresented in South American Museums. These species with which he is familiar, as well as those known only from the literature, are subjected to the most casual, and in most cases, ill-advised synonymizing. . . . ."

It seems reasonable to maintain this isolated form as a distinct species until large series are available for comparison. I am personally convinced that the species is distinct.

Fray Inigo Abbad y Lasierra, 1788 tells a "snake story" on this species which for its audacity of conception deserves repeating. He says in substance that this snake inhabits houses and hunts rats at

NOTE: Mrs. Haydon has found that the boas readily eat white rats although they constrict and kill more than they eat. It is interesting to consider what their natural food may have been before the relatively recent introduction of the rat.

night. The snake fastens its head to the floor and raising its body in the air uses it as a flail to slay the rats.

Epicrates monensis Zenneck.

This species is admirably described by Stejneger in "The Herpetology of Porto Rico" from 5 specimens in the Hamburg Museum.

There is one specimen in the Field Museum.

My three specimens, all young, 390, 800 and 810 mm. in total length respectively, agree with Stejneger's description, except in the following: scale rows at mid-body 40, 44, 46, whereas he gives 43 as the maximum; subcaudals 74, 75, 87, whereas his minimum is 79 and maximum 82; supralabials 12–13, 13–14, 14–14, whereas he gives 11–13, 13–13, 13–13, 13–13, 13–13. These amplitudes tend to show slightly greater differences from *E. fordii* than appear in existing descriptions.

The species is rare in collections and practically unknown to the inhabitants of Mona Island. The last recorded specimen, before mine, was taken in 1892.

There have been attempts made to synonymize this species with *E. fordii*, all of which have been rebutted. The last is Amaral (1) who is rebutted by Stull (2) as follows: "The form *Epicrates monensis* Zenneck is synonymized with *E. fordii* (Gunther), although it can be distinguished from the latter not only by its coloration, particularly the considerably smaller number of dorsal spots, but also by apparently constant differences in the numbers of scale rows, ventrals, and caudals. . . . ."

(1) Amaral, A. do. Valor Systematico de Varias Formas de Ophidios Neotropicos. Mem. Inst. Butantan, IV, pp. 1–68, 1929. . . . . ., Lista Remissiva dos Ophidios do Brasil. *Ibid.*, IV, pp. 70–125. . . . . ., Lista Remissiva dos Ophidios da Regiao Neotropica. *Ibid.*, IV, pp. 126–271.

(2) Stull, Olive Griffith, Corrections to Some Recent Papers on Neotropical Snakes. Bul. Antivenin Inst. of Am. V, No. 2, pp. 39–41, Sept. 1931.

Explanation of Plate XXXVIII

Fig. 1. *Epicrates monensis*, young.
Fig. 2. *Epicrates inornatus*, young.

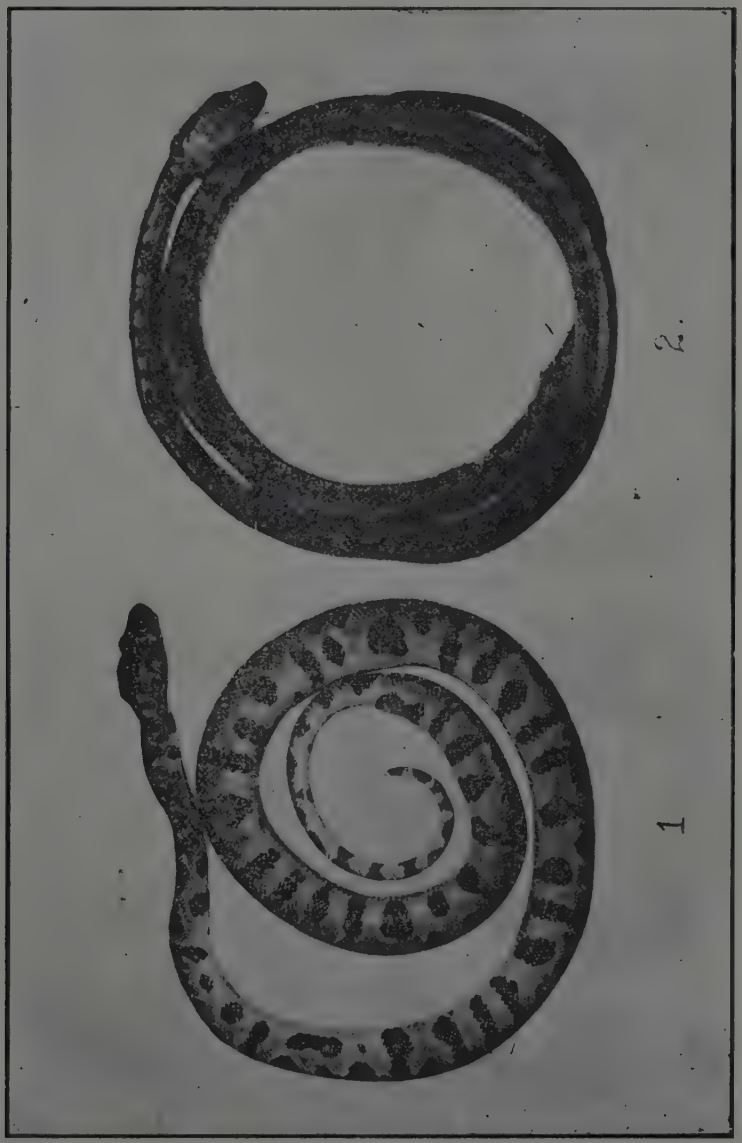
2.
1.

PLATE XXXIX

PLATE XL

PLATE XLI

PLATE XLII

THE HERPETOLOGY OF ST JOHN AND ADJACENT KEYS, U. S. VIRGIN ISLANDS

CHAPMAN GRANT, *Major, U. S. Army.*

The arid appearing little Island of St. John lies east of St. Thomas. There is no industry and practically no cultivation except where the scattered negro population tends patches of truck. Mountain trails connect the ruined Dutch manor houses, which flourished in the days of rum and slavery. Schools are plentiful and well attended. Cattle, horses and mongoose are much in evidence. The last has practically exterminated land turtles, ground lizards and snakes.

The principal incentive to visiting St. John, from April 13–17, 1932, was to try to enlarge the herpetological check list which Barbour limits to five species in "Zoologica", Vol. XI, No. 4, 1930. It is easy enough to assume what species probably occur on an Island, but there is greater satisfaction in actually collecting the specimens.

Barbour lists—1. *Ameiva exsul;* 2. *Amphisbaena fenestrata;* 3. *Mabouia sloanii;* 4. *Alsophis antillensis,* and 5. *Dromicus exiguus* only. Of these, *M. sloanii* should undoubtedly read *M. semitaeniatus.* I believe the former is confined to P. R. The latter has probably reached the verge of extermination on St. John, as I saw no specimens and the natives did not recognize a sample shown them from Culebra. They say that snakes are very rarely seen. *Ameiva* seems to be restricted to the neighborhood of the settlement at Cruz Bay, where the mongoose is kept off by the dogs.

The following is probably the latest and most complete list from this area:

1. *Eleutherodactylus antillensis,* (Reinhardt & Lutken). Numerous under banana sheaths, sometimes in groups of eight or more.

Occasional specimens were found in the axils of *bromeliads.* The black loreal region and bright red eyes were prominent. The back is colored terra-cotta, tan, pink or rarely gray. The voice did not seem to differ greatly from the Puerto Rico specimens.

Specimens taken ---------- 72

2. *Eleutherodactylus cochranae* sp. nov.

It is described elsewhere in this number. They were found ex-

clusively in the axils of *bromeliads,* together with a few *E. antillensis.* The voice was not heard.

Specimens taken 210

3. *Leptodactylus albilabris* (Gunther).

Plentiful under rocks in the muddy ponds along dry stream beds. They have striking differences from their Puerto Rican counterparts but closely resemble the St. Thomas topotypes, of which I took 7 specimens. It would appear that the P. R. species is different. The St. John species has the upper surface black, the throat heavily marked with black and the snout developed for burrowing, whereas the P. R. form is diversely colored above, white underneath. Many froth nests were found containing eggs and larvae.

Specimens taken 73

4. *Hemidactylus mabouia* (Moreau de Jonnes).

Found in frame buildings and under living banana sheaths. In this it shows a different habitat from *H. brookii* of P. R., which resorts to mortar or stone buildings. Known as "Wood slaves" to the natives.

Specimens taken 21

5. *Sphaerodactylus macrolepis* Gunther

These agree with specimens from St. Croix and Water Island, St. Thomas. The male has a gray body and "Target" pattern head. No red-head males seen, which further strengthens the validity of *S. danforthi,* of Culebra and Vieques. Numerous in favored places.

Specimens taken 22

6. *Anolis cristatellus* Dumeril & Bibron

Numerous and showed no variation from those of St. Thomas, except that on Stephen Key the tail crest was extremely high. None of the highly patterned females was seen as on Puerto Rico. I believe two species are found together on Puerto Rico and are grouped as one.

Specimens taken 16

7. *Anolis pulchellus* Dumeril & Bibron

Not numerous. The fan does not have the crimson center seen on the Puerto Rico specimens.

Specimens taken 24

8. *Anolis stratulus.* Cope

Uncommon. Found from the mangroves at sea level to the hill tops. The fan is of a deeper yellow than on Puerto Rico.

Specimens taken ---------- 23

9. *Ameiva exsul.* Cope

This species is listed by Barbour. Numerous near the buildings at Cruz Bay where the dogs keep the mongoose away. No large specimens seen. Where the mongoose is numerous, large *Ameivas* are seldom seen. The natives say the "ground lizard" is found nowhere else on the island.

Specimens taken ---------- 19

10. *Mabouia semitaeniatus.* Wiegmann.

Not seen. Probably near extinction. This species is doubtless what occurred here, but is listed by Barbour as *M. sloanii,* which I believe occurs only on Puerto Rico. The natives did not recognize pictures of this species.

11. *Amphisbaena fenestrata.* Cope.

Not seen. Listed by Barbour. Doubtless numerous but there is so little cultivation that opportunities for taking it are few.

12. *Typhlops jamaicensis* (Shaw)

Two specimens sent me by Mr. B. E. Bauman may be referred to the above species pending a revision of the material from this area.

Specimens taken ---------- 2

13. *Alsophis antillensis* (Schlegel)

Probably extinct on St. John. Two specimens taken on Dog Island. Said on good authority to occur on Lovango and Congo Keys.

Specimens taken (Dog Island) ---------- 2

14. *Dromicus exiguus.* Cope.

Not seen. Listed by Barbour. This is probably the species that is still occasionally seen by the natives. Probably occurs on the outlying keys as well.

15. *Testudo tabulata.*

Still occurs feral on Lovango Key and Water Island. There is excellent authority for including this species which was omitted by later writers. To be treated in another paper.

Specimens taken (Water Island) ---------- 3

A group of three islets lies between St. Thomas and St. John, known from east to west as Dog Island, Little St. James and St. James.

Dog Island is the smallest, is treeless and absolutely carpeted with cactus, bearing the finest exhibit of *Cactus intortus* I have ever seen. Specimens taken:

1. *Anolis cristatellus* ---------- 2
2. *Alsophis antillensis* ---------- 2

Little St. James is much larger, has a few thickets and small trees and plenty of cactus and thorns. Specimens taken:

1. *Sphaerodactylus macrolepis* ---------- 2
2. *Ameiva exsul* ---------- 2
3. *Anolis cristatellus* ---------- 3
4. *Anolis pulchellus* ---------- 2

Northwest of St. John lie two narrow keys, Congo and Lovango, parallel and separated by a narrow channel. The former is a steep mass of diorite covered with trees and cactus. The latter is earth covered, grass grown and practically treeless.

Congo Key:

1. *Sphaerodactylus macrolepis* ---------- 6
2. *Anolis cristatellus* ---------- 1
3. *Anolis stratulus* ---------- 3

Lovango Key:

1. *Ameiva exsul* ---------- 3
2. *Anolis cristatellus* ---------- 4
3. *Anolis pulchellus* ---------- 1

Excellent authority points to the occurrence of *Testudo tabulata* on Lovango and *Alsophis* on both keys.

A GENUS OF GECKO NEW TO THE GREATER ANTILLES

CHAPMAN GRANT, *Major, U. S. Army.*

The only mention of the genus *Phyllodactylus* in the West Indies is in Barbour's List of Antillean Reptiles and Amphibians, 1930, Page 82. "*Phylodactylus spatulatus* Cope. Collected years ago in Barbados, about 1861, in fact, by Dr. Theodore Gill. I have no recent information as to its status."

The January, 1932, number of this Bulletin contains a joint article on the herpetology of Caja de Muertos Island in which the writer and Cornelius Roosevelt report the capture of two specimens of *Phyllodactylus spatulatus* Cope.

The identification was made by comparison with some poor specimens kindly loaned for the purpose by the National Museum. The specimens appeared to differ somewhat, but no better comparisons seemed feasible in the time available.

On December 26, 1931, the writer was collecting on a hilltop near Parguera in southwest Puerto Rico. The third and largest specimen was collected from under a small dry log.

The three specimens were taken to the American Museum where, although no specimens were available for comparison, identification was made as closely as possible from a book as *P. pulcher,* Gray.

The type specimen is in the British Museum. Type locality, tropical America.

It now remains for the academic scientist to explain the presence of this little waif in Puerto Rico in terms calculated to quiet further questioning. It may be a "flotsam-jetsam arrival" or have arrived "fortuitously through nonhuman agencies", or across a "land bridge". Personally I believe that the following quotation should amply account for it. "It must be recognized that evolution in the direction of habitat restriction may strictly parallel an evolution in which the primitive forms become peripheral by retreat in space". What more could be said.

Some measurements of the three specimens:

	1	2	3	
Snout to vent	28.	41.	45.	mm.
Snout to ear	9.	12.5	13.5	mm.
Vent to tail tip	---	----	53.	mm.

There is no femoral scale differentiation; consequently the three specimens are probably females.

A description of the third and largest specimen follows:

Phyllodactylus pulcher.

Diagnosis: A gecko of moderate size, the digits expanded at the ends into a pair of large lamellae, between which a small claw protrudes; 20 rows of large dorsal tubercles, keeled, closely set; no tubercles on tail; color brown, transversely striped with eight light bands outlined in dark brown, nape to pelvis; seven light rings on tail; rudimentary eyelids provided with about six short black spines posteriorly.

Habitat: Caja de Muertos Island and Southwest Puerto Rico; "Tropical America."

Squamation: Rostral broader than high, squarish, slightly creased medially above, higher than labials, narrower than mental, in contact with two supranasals; nostril at point of contact of rostral, supranasal and first supralabial followed by two postnasals; six supralabials, fifth ending just posterior to pupil, followed by small scales; top of head covered with large roughly hexagonal tubercles, about 13 between eyelids; posteriorly on head tubercles interpersed with granules; eye slightly nearer to snout than to ear; its diameter being 1½ its distance from snout, rudimentary eyelid furnished with six or more short sharp black spines posteriorly; ear opening elongate, oblique, unarmed; mental pentagonal, wider than rostral, 4 large infralabials followed by several small ones, two chin shields, irregularly pentagonal, their anterior angle fitting into corner between mental and part of first infralabial, broadly in contact with each other on the median line, followed by two rows of about 6 somewhat enlarged flat scales, then by small flat scales to neck; neck to vent and lower surface of legs covered by larger smooth, imbricate cycloid scales, about 22 across center of body, about 50 neck to vent; upper surface of body, flanks and legs covered by large keeled tubercles, the two median rows elongated, the rest nearly round, ten rows across center of back, 33 rows occiput to base of tail; tubercles separated by about one granule front to rear and two laterally; fingers and toes all with about 10 rows of transverse lamellae the terminal few in pairs; terminally two large square lamellae, between which protrudes a small claw; dorsal aspect of digits resembles a lobster telson; tail cylindrical, covered above and laterally with large imbricate scales irregularly interspersed with small similar

scales, underside one row of transverse scales, all scales pitted over their entire surface.

Color and markings: Upper surface brown and light; a dark brown diamond with light center on snout; head marbled brown and light; dark transocular stripe, snout to ear; 11 alternate light and dark transverse bands, nape to base of tail, edged with darker brown; tail similarly ringed with about 15 alternate rings; underside, light, finely specked with brown, several specks on each scale except under jaws where each scale bears one brown speck. Young more vividly colored than larger specimens.

Pupil vertical with wavy edges. Undoubtedly a species of nocturnal habits.

Reference: Gray, Spicil. Zool., Vol. 1, p. 3, pl. 3, Fig. 1.

Explanation of Plate XXXIX

Phyllodactylus pulcher, young.

HERPETOLOGY OF TORTOLA; NOTES ON ANEGADA AND VIRGIN GORDA, BRITISH VIRGIN ISLANDS

CHAPMAN GRANT, Major U. S. Army

There are several theories advanced to explain the distribution of the flora and fauna of the West Indies. This is a problem for the Biologist, Botanist and Geologist to work out together. The superficial appearances are that land connections existed with North America via the Bahamas; with Central America; with South America. How extensive these connections were in both time and space is conjecture. For that matter, the whole Caribbean Sea may have been land at one time. The solution of the problem can be helped by knowledge of the species of plants and animals that inhabit the islands. With this end in view, the writer visited Tortola from August 10th to 16th, 1932. The results were gratifying.

The most complete and accurate compilation of the herpetological fauna of this area is Barbour's "A List of Antillean Reptiles and Amphibians" Zoological, XI, No. 4, 1930. Therein are listed eight species from Tortola. The writer had the satisfaction of adding nine species to this list and one to Barbour's list of seven from Anegada. He also added four *Cactaceae* to Dr. Britton's list from Tortola, and added specimens and information on the herpetology of St. Thomas and St. John. The last was previously described in this Journal, adding ten to Barbour's five listed species. The present trip produced another from St. John, making the total from that island sixteen. The writer's stay on Tortola was made pleasant and profitable by the hospitality of Commissioner Clarkson and the enthusiasm of Mr. Fonseca.

The following annotated list is the result of the trip:

Bufo turpis Barbour

Found only on Virgin Gorda. The type, and seven specimens taken by Dr. Danforth of Mayagüez in 1931 are the only specimens known.

Eleutherodactylus portoricensis Schmidt

Known locally as "bo-peep". Not listed by Barbour.

The discovery of this species on Tortola is of especial interest on account of the light it throws on frogs of the same name in Puerto Rico. The series of 44 from Tortola shows very little variation in

color, pattern, size or voice. This strengthens the conviction that two or more species are included under this name in Puerto Rico. The Tortola specimens have a light gray back, white belly, no pattern or marking other than a dark canthus rostralis and occasionally orange on covered surface of thighs. The voice has no variations as on Puerto Rico. Their song is heard everywhere from afternoon throughout the night. They seem greatly to outnumber *E. antillensis,* judging from the volume of sound, as compared to the relatively uncommon "click-click-click" of the latter.

Specimens taken: Tortola, 44.

Late one evening while tacking up the channel between St. John and Thatch Island of Tortola, the "bo-peep" of *E. portoricensis* could be heard each time that the shores of St. John were neared. This adds a new record to the herpetological list of St. John.

Eleutherodactylus antillensis (Reinhard & Lütken)

No local name. This species is confounded by the natives with *E. portoricensis* as a "bo-peep". Listed by Barbour. Uncommon, not found on adjacent islets. The voice, a "click-click-click" is identical to the Puerto Rico and St. John specimens. Color much darker; no terracotta or gray backs seen; one specimen had a violet-pink back. The characteristic red eye, black canthus rostralis and reticulated thighs present. The voice is seldom heard among the babel of "bo-peep" of *E. portoricensis.*

Specimens taken: Tortola, 6.

NOTE: The voice of another species, resembling that of *E. gryllus* was heard, but the frogs were not located.

Leptodactylus albilabris (Günther)

Known locally as "water frog". Listed by Barbour. Not found on any surrounding islets. Numerous; breeding. Voice same as elsewhere. Individuals average darker with more spotted throat than on Puerto Rico but much lighter than the St. Thomas and St. John forms which have a much more spotted throat. No large specimens seen as on Puerto Rico.

This frog has a throaty chuckling trill, apparently used during uncertainty as to threatening danger. It follows or precedes the song which is "creep", repeated many times. The "pink" mentioned by Stejneger is really a single note, often repeated and sounding like a sharp instrument being tapped on metal. Individuals seem to give this in different keys. There are other little notes that sound almost like a conversation.

Specimens taken: Tortola, 50.

Hemidactylus mabouia (Moreau de Jonnés)

Locally shares the name of "wood slave" with the Giant *Anolis*. Listed by Barbour. This is the real *H. mabouia* and not the *H. brookii* Gray of Puerto Rico that long masqueraded under this name. None seen on buildings at night. Rare.

Specimens taken; Peter Island, 2. A small *Alsophis antillensis* taken at the same time and place disgorged an adult *H. mabouia*.

Sphaerodactylus macrolepsis Günther

Locally known as "cotton ginner". Listed by Barbour. Common. Found on most of the outlying islets. No red-head males taken or seen. This further strengthens the position of *S. danforthi*, which is similar, but has a proportion of red-head males. It has none of the characteristics of the distinct *S. grandisquamis* Stejneger of Puerto Rico.

Specimens taken: Tortola, 145; Peter Island, 1; Buck Island 13. Seen on Guana Island.

Iguana iguana

Known locally as "guana". Not listed by Barbour. Guana Island derives its name from this species. It is not used for food by the natives. Known only from Guana Island and Peter Island of the British Virgins. No specimens taken but one seen on Peter Island.

A previous report was made of taking iguanas on Water Island, St. Thomas. On this trip a specimen was taken on Hassell Island, St. Thomas, and one was seen in a grape arbor in the City of St. Thomas. They are said to be numerous at Botany Bay. An *Alsophis antillensis* taken on the beach of Water Island had eaten three baby iguanas, probably recently hatched. These were bright green, tail ringed brown, green and blue. The most noticeable mark is a white stripe from neck to elbow. Snout to vent 75 mm.; tail 190 mm. A story prevalent among the natives, and seemingly true, is that the iguana will take refuge by diving into the sea where it will cling to the rocks. The eggs, to the number of 30 or more, are buried in beach sand. The tracks and mark of the dragging tail are a common sight on the beaches. Barbour lists *Iguana rhinolopha* Wiegmann and *Iguana delicatissima* Laurenti as the only species of this genus occurring in the West Indies.

I. rhinolopha has tubercles on the snout and *I. delicatissima* has 19–20 femoral pores. The Virgin Islands specimens have smooth

snouts and only 13–15 pores, placing them with *I. iguana,* which has 12–18 pores.

Anolis cuvieri Merrem.

Possibly known locally as "wood slave". Listed by Barbour. None seen. Inasmuch as a distinct species *A. roosevelti* Grant is found on Culebra, the occurrence of this species on Tortola is doubtful. A giant *Anolis* on Tortola would probably be a distinct species.

Anolis cristatellus Duméril & Bibron

Known locally as "man lizard", "doctor lizard" and "common lizard". Listed by Barbour. Very numerous. The green and red of the throat fan is constant here and not subject to the great variation seen on Puerto Rico. The tail fin on males from some of the islets is extremely high. One specimen from Guana Island has the fin rays as long as snout to posterior part of orbit, or 3½ times as high as tail is deep at that point, or 15 mm. high. This is the highest fin I have ever seen.

Specimens taken: Tortola, 63; Peter Island, 10; Guana Island, 2; Fallen Jerusalem, 5; Anegada, 15. Seen on all small islets visited.

Anolis pulchellus Duméril & Bibron

Known locally as "snake lizard". Listed by Barbour. Numerous in grassy places. Apparently identical to the Puerto Rico specimens, except that on Puerto Rico this species is unique in having a crimson center to the red fan.

Specimens taken: Tortola 23; Peter Island 2; Guana Island 1.

Anolis stratulus Cope

Known locally as "salmon lizard". Listed by Barbour. Very numerous. Average much lighter colored with deeper orange fan than the Puerto Rico specimens; hence the dorsal marks are much more pronounced. When threatening fight, the males protrude a blood red tongue which at other times is pink.

Specimens taken: Tortola, 40; Peter Island, 2; Guana Island, 1. Seen on Fallen Jerusalem.

Cyclura pinguis Barbour

Known locally as "guana". Listed by Barbour as "excessively rare if not now gone". Now reported numerous on Anegada. Color notes from living specimens: Tongue and lining of mouth pink pupil vertical, iris dark brown but small, leaving the white of the

eye so prominent as to appear to be a white iris. Above: face, sides of head, between eyes and lower jaw bulbs olive; strip across nostrils including the turtle-like rostral, postocular bulbs and "cape" reaching to shoulders, dark brown reticulated with black; thence to base of tail black reticulation more prominent, forming three black chevrons, points at crest; tail dull turquoise blue reticulated with black on basal third, thence brown; caudal crest turquoise. Below: dewlap and chest mahogany, fading to gray on belly and tail; occasional dark scales form patterns on undersides of legs and sides of body and especially on posterior aspect of thighs. The scales of back and sides are soft and granular, giving a leathery appearance and texture.

Specimens taken: Anegada, 2 young males. Snout to tip of tail 1,075 mm.; snout to vent 410 mm. These are about two-thirds adult length and about one-third bulk.

Ameiva exsul Cope

Known locally as "ground lizard". Not listed by Barbour. Common in flat or sandy places on Tortola and adjacent keys. On Tortola this species is dark, loses its dorsal stripes early in life and does not have the reddish or lavender chin frequently seen elsewhere. It coincides exactly with the species on Puerto Rico in femoral pore count. There is a wider variation in anal plates, but not to a significant degree. Altogether, it is the least attractive representative of the species in the area. No large specimens were seen, probably due to the mongoose. Two large specimens from Buck Island were colored in the same drab fashion, but Guana Island, Peter Island and Anegada produced large, highly colored specimens, with prominent dorso-lateral stripes, reminiscent of similar ones on Culebra. One Peter Island specimen had particularly noticeable turquoise blue on the sides of head and neck. A color combination new to me. The bright colored specimens had a lower pore count, but there were not enough taken to determine whether this was of any significance.

Specimens taken: Tortola, 34; Peter Island, 4; Buck Island, 2; Guana Island, 2; Anegada, 2. The specimens from Anegada are a new record from that Island.

Amphisbaena fenestrata Cope

Known locally as "ground worm". Not listed by Barbour. The specimens taken differ from *A. fenestrata* in having only one temporal scute instead of two, and 16 segments below the lateral line

instead of 14. It may remain in this species pending further comparison. It is difficult to procure as "there is not a plow in Tortola".

Specimens taken: Tortola, 5.

Mabuya semitaeniatus (Wiegmann)

Known locally as "slippery back". Not listed by Barbour. Rare. The one specimen taken on Salt Island does not coincide in color or squamation with a series of 155 specimens from Culebra, Mona and Buck Island, of St. Thomas. It is still further removed from *M. sloanii* (Daudin) of Puerto Rico. It may remain as *M. semitaeniatus* pending comparison with more material.

Specimens taken: Salt Island, 1.

Typhlops richardii Duméril & Bibron

Known locally as "ground snake". Not listed by Barbour. This species has the dark mahogany coloration and small size of *T. rostellatus* Stejneger, but lacks the white chin and tail markings. It is smaller than *T. jamaicensis* (Shaw), lacking the white caudal notch or ring and the light venter.

This species is reestablished pending a study of the material from this area, of which 225 specimens from Vieques, Culebra, Mona, St. John, St. Thomas, Caja de Muertos, Tortola and Puerto Rico are in my collection.

Found under a heap of bagasse at a rum mill, apparently preying upon small life, together with the *Amphisbaena* and the three species of frogs. Shed skins had the appearance of quills, not collapsing like ordinary snake skins.

Specimens taken: Tortola, 32.

Epicrates sp.

Species to be described later.

Known locally as "night snake". Not listed by Barbour. Said to attain five feet or more in length. Inhabits rocky cliffs on Tortola and Guana Island. It was a great surprise to find a boa so far east of the eastern record of this family, *Epicrates inornatus* (Reinhardt) of Puerto Rico, and greatly lessening the gap to Dominica and *Constrictor orophias* (L), the northern limit of the family in the West Indies.

Specimens taken: Tortola, 1.

Alsophis antillensis (Schlegel)

No local name other than "snake". Not listed by Barbour from Tortola. Listed from Virgin Gorda.

This snake varies considerably on the different islets. A specimen from Salt Island being typical of a large series from Culebra. Two from Peter Island are uniquely marked; four scales of the fourth, fifth and sixth rows forming a white spot with a dark border. There is a checkerboard pattern on the neck. The throat of all specimens is straw yellow in life. One specimen from Peter Island disgorged an adult *Hemidactylus mabouia.* A specimen from Water Island, St. Thomas, contained three young *Iguana iguana.* This snake is most readily found at early morning along the beaches. It is seldom met with after 10:00 a. m. Reported very rare on Tortola but said to occur on all the islets around.

Specimens taken: Salt Island, 1; Peter Island, 2.

Dromicus exiguus Cope

No local name for this species which is apparently locally considered to be the young of Alsophis. Not listed by Barbour. Frequently met with by persons gardening or cultivating. Two specimens reported to have been found "torpid" in the "Winter" in the cracks of an old wall which was being demolished. Apparently identical to St. Thomas specimens.

Specimens taken: Tortola, 2.

Testudo tabulata

Known locally as "land turtle". Not listed by Barbour. According to inhabitants, occasionally met with in the "bush" on Tortola but "none seen within two years". The certainty with which natives state that none occurs on any of the outlying islets, lends strength to their statements of its occurrence on Tortola. Another check is the immediate answer that there are no fresh water turtles.

Excluding *Testudo tabulata,* the above list adds 9 species to Tortola and its adjacent islets that are new to Barbour's list of 8 and gives the island a population of 17 species.

The most important finds were the discovery of the boa and that *E. portoricensis* is not confined to Puerto Rico.

The *cactaceae* listed by Britton from Tortola are: *Cephalocereus Royeni; Hylocereus undatus; Selenicereus grandiflorus; Cactus intortus; Neomammilaria nivosa; Opuntia repens; O. antillana; O.*

rubescens. Of these, *H. undatus* was not found, but *Hylocereus trigonus* (Haw.) Stafford was found to be abundant and is added to the flora of the island together with *Opuntia Dillenii* (Ker-Gawl) Haw.; *Opuntia triacantha* (Willd.) Sweet; *Lemaireocereus hystrix* (Haw.) Britton & Rose, all of which are abundant.

Explanation of Plates

Plate XL. *Cyclura pinguis.* Note the whites of the eyes, large nostrils and muscular bulb of lower jaw.

Plate XLI. Same; note throat fan and absence of rostral spines.

Plate XLII. Same; note lateral fold, smooth snout and throat fan.

o–O–o